AN ANALYSIS OF ANGLER SURVEYS ON SELECTED LAKES IN WHITESHELL PROVINCIAL PARK: MANAGEMENT IMPLICATIONS

by
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ABSTRACT

Angler field surveys were conducted on Falcon and Big Whiteshell Lakes in 1982, and on Brereton and Nutimik Lakes in 1983 in order to determine characteristics and trends of the fisheries in these lakes. The results will aid in fisheries management of intensive recreation zone lakes in Whiteshell Provincial Park. A roving creel census technique was used in the survey.

Few non-resident anglers used the fisheries. Cottagers and campers combined comprised between 70% and 88% of anglers on each of the lakes. On all four lakes, walleye (Stizostedion vitreum) harvest - and sauger (Stizostedion canadense) on Nutimik Lake - was greater than estimates made from past surveys.

Falcon Lake experienced low effort by anglers, but provided the poorest angling quality (0.27 fish caught per angler-hour). The exploitation level was low at 31% of production potential. Angling improved markedly after 1 July.

Big Whiteshell Lake provided a good quality of angling (0.41 fish per angler-hour). Angling success was markedly better before 1 July. Only on this lake were northern pike

(Esox lucius) harvested in significant numbers. The fishery on Big Whiteshell Lake showed no signs of deterioration or over-fishing. The exploitation level was 52%.

The yield (4.00 $kg.ha^{-1}.yr^{-1}$) and exploitation level (95%) on Brereton Lake were high. Day-users were more numerous on Brereton Lake than on any other lake. They angled for a longer period of time, and harvested a larger percentage of fish, than any other group. Brereton Lake appears to have been overharvested.

Yield was high on Nutimik Lake, but has consistently been high in the past. Catch of lake sturgeon (Acipenser fulvescens) per unit effort has declined over time.

To maintain an acceptable catch per unit effort in the 0.25 - 0.50 fish per angler-hour range, management strategies encouraging conservation and less consumptive use must be implemented. The co-ordination of a variety of programs that monitor and maintain the fish resource will be necessary. Public education will also be important.

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DEFINITION OF TERMS

Angler-day - One angler, fishing for any part of one day (e.g. one angler fishing for all or part of two different days = two anglers fishing for all or part of one day = two angler-days).

Angler-hour - One angler fishing for one hour (e.g. one angler fishing for three hours = three anglers fishing for one hour = three angler-hours).

Angler field survey - A survey conducted by obtaining a random sample of one day creel censusses. The census is ideally a complete enumeration of the anglers' creel (Cochran 1963). Many authors have applied the term creel census to the overall survey.

Bias - The average of the absolute values of the errors in making an estimate (Snedecor and Cochran 1967).

Catch per Unit Effort (CUE) - The weight (or number) of fish caught per angler-hour (Malvestuto et al. 1978).

Creel Census - The fishing process is directly observed, anglers are interviewed in action to determine the kind and numbers of fish taken and the rates at which they are caught (Robson 1961).

Edaphic - from Greek "edaphos" - bottom. In the morphoedaphic index, it denotes the effects due to soil or topography rather than climate (Ryder et al. 1974).

Effort - (Fishing effort or angling effort). The time spent angling, expressed in angler-hours or angler-days (Grosslein 1962).

Euphotic zone - The lighted region that extends vertically from the water surface to the level at which photosynthesis fails to occur due to insufficient light penetration (Hughes 1983).

Eutrophic - Waters containing a rich supply of plant nutrients that support heavy growths of algae and aquatic plants. The increase in algae causes a decrease in the penetration of light. Deep areas may exhibit oxygen depletion due to the decomposition of dead organisms (Hughes 1983).

Exploitation level - Estimated yield divided by production potential multiplied by 100%.

Fishery - A system composed of three interacting components: the aquatic biota, the aquatic habitat, and the human users of these renewable natural resources (Lackey and Nielsen 1980).

Harvest - Total biomass of fish removed from a waterbody in a year (Schlesinger and McCombie 1983).

Ichthyomass - The living weight of fish (adapted from Smith 1974).

Lentic - Calm or placid, as ponds or lakes (Needham and Needham 1962).

Littoral - The shallow water zone of a waterbody, where light penetrates to the bottom (Smith 1974).

Lotic - Flowing, as in river and stream water (Needham and Needham 1962).

Macrobenthos - Those organisms inhabiting the bottom substrate of lakes, ponds and streams that are retained by a no. 30 U.S. Series sieve (Lind 1974).

Mesotrophic - Waters characterized by a moderate nutrient supply and organic production (i.e. midway between eutrophic and oligotrophic) (Hughes 1983).

Morphometry - from Greek "morph" - form (Ryder et al. 1974). The shape of a basin (Lind 1974).

Morphoedaphic index (MEI) - An empirically derived formula (total dissolved solids divided by mean depth) that provides a means of estimating the potential productivity of a lake (Ryder 1965).

Non-Resident - A holder of a non-resident angling license. (i.e. an angler who is not a Canadian resident).

Oligotrophic - Waters containing a poor supply of plant nutrients resulting in little algae and aquatic plant growth. The waters are generally clear permitting extensive light penetration. Oxygen in the bottom waters is abundant (Hughes 1983).

Precision - The size of deviations from the estimated mean obtained by repeated application of the sampling procedure. This is different from accuracy in that accuracy refers to the size of deviations from the true mean (Cochran 1963).

Production potential (potential yield) - A prediction of the probable maximal level of yield that will be attained in a specific self-renewing resource, given a rate of development intended to reach this maximum in a relatively short period of time (Henderson et al. 1973).

Resident - A holder of a resident angling license (i.e. an angler who is a Canadian resident).

Roving creel census - A creel census in which the information collector moves through the fishing area, interviewing anglers as he encounters them (Robson 1961).

Total dissolved solids (TDS) - The filtrable residue or residue on evaporation, TDS is determined by filtration and evaporation. The residue after evaporation is dried to a constant weight in an oven at 103 - 105° C and weighed (Ryder et al. 1974).

Yield - Harvest of fish per unit area (Schlesinger and McCombie 1983).

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Chapter I

INTRODUCTION

Problem Statement

Management of fisheries in the intensive recreation zones of Whiteshell Provincial Park should maintain and/or enhance angling opportunities (Manitoba Department of Natural Resources 1983a). These opportunities imply an angling quality that provides a reasonable catch per unit effort. Catch rate is a function of the production potential of the fish resource, and the harvest of fish made by the number of anglers using the resource.

The following parameters of fisheries in the intensive recreation zones are not adequately known: the numbers and characteristics of the anglers using the fisheries; the catch per unit effort they experience; and whether the resulting harvest and catch rate is sustainable.

Management strategies which will provide reasonable angling opportunities, now and in the future, are required. Reliable estimates of the parameters listed above are necessary for the development of such management strategies.

Objectives

For each of the selected lakes:

1. To describe the numbers and characteristics of the anglers using the fishery:

   1.a.) to estimate the fishing effort,

   1.b.) to estimate the proportion of anglers holding each different license type,

   1.c.) to estimate the proportion of anglers using each available accommodation type.

2. To describe the catch per unit effort experienced by anglers:

   2.a.) to estimate the average catch per unit effort,

   2.b.) to estimate the catch per unit effort for different user groups.

3. To describe the status of the fisheries resource base relative to angling harvest and effort:

   3.a.) to estimate fish harvest and yield,

   3.b.) to estimate the biological production potential,

4. To assess the management implications:

   4.a.) to develop goals for management of Whiteshell intensive use zone sport fisheries,

   4.b.) to make specific management recommendations.

Study Area

Whiteshell Provincial Park is located in southeastern Manitoba, adjacent to the Manitoba-Ontario border, and is approximately 120 km east of Winnipeg (Fig 1). Whiteshell was Manitoba's first provincial park, and is today at 2764 km^2, the largest in Manitoba's system of parks (Manitoba Department of Natural Resources 1983b). Whiteshell is located on the southwestern edge of the Precambrian Shield. Forty to 60% of the surface area is covered by bogs or lakes. Natural vegetation of the Whiteshell is primarily mixed woods and northern coniferous forest.

The Whiteshell Master Plan (Manitoba Department of Natural Resources 1983a) was adopted by the Department of Natural Resources in August 1983, and is currently (January 1985) in the process of being implemented. This plan identifies five different types of zones within Whiteshell. One of these types of zones, the intensive recreation zone, is comprised of nine areas adjacent to the major road-accessible lakes within the park (Fig 2). The cumulative size of these areas is 303 km^2, about 10% of the park area. The four lakes chosen for the study: Falcon, Big Whiteshell, Nutimik, and Brereton Lakes, are adjacent to, or are included within an intensive recreation zone.

Several of the lakes in the intensive recreation zones provide a walleye (*Stizostedion vitreum*) - northern pike

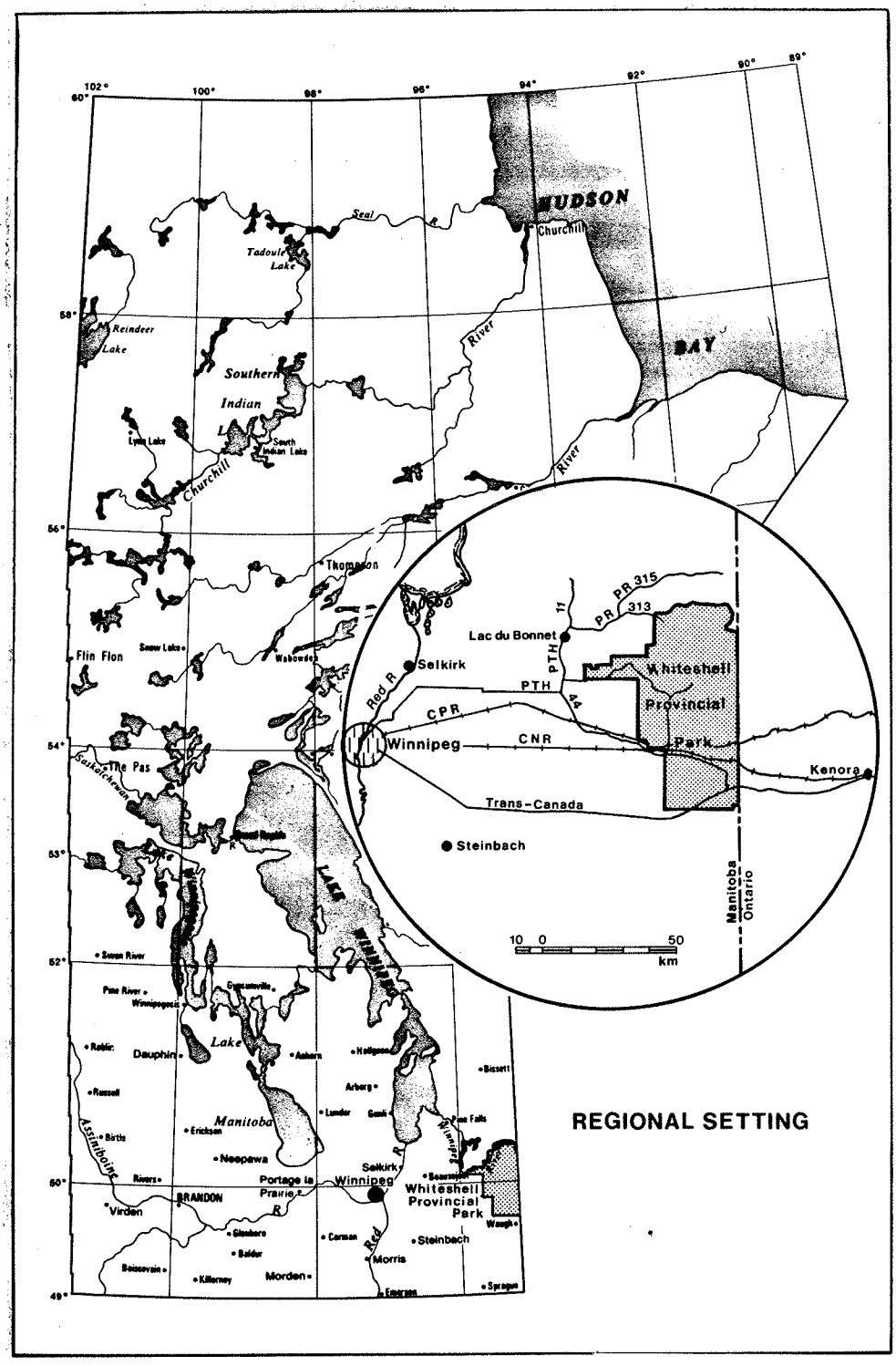


Figure 1. Regional Setting of Whiteshell Provincial Park.

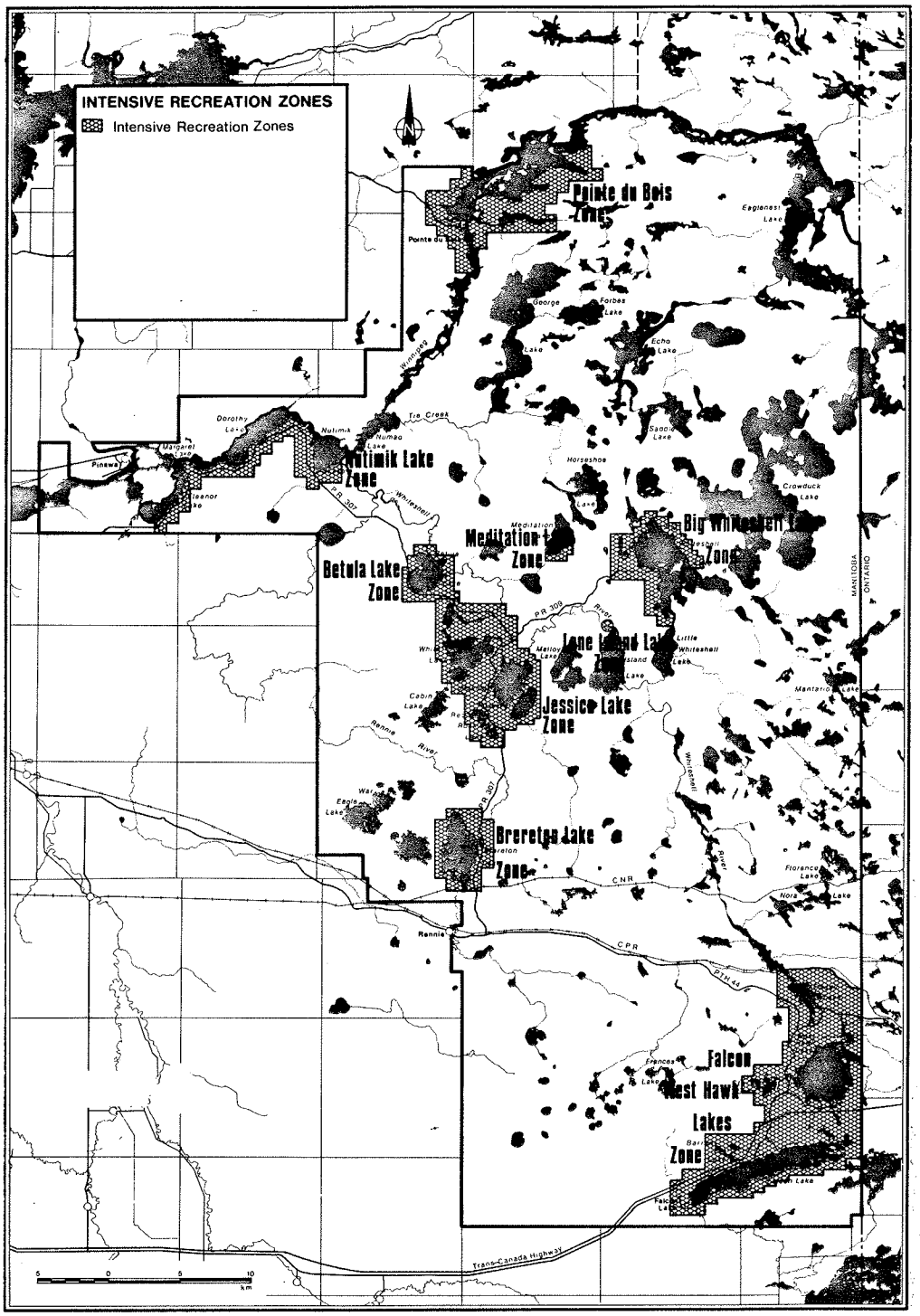


Figure 2. Intensive Recreation Zones in Whiteshell Provincial Park.

(Esox lucius) fishery (Table 1). Included in this category are Big Whiteshell Lake and Brereton Lake. Other game fish species found in all of the lakes include yellow perch (Perca flavescens). As well as those species mentioned above, smallmouth bass (Micropterus dolomieui) are present in both Falcon and Nutimik Lakes. In addition, Nutimik Lake supports sauger (Stizostedion canadense), mooneye (Hiodon tergisus), and lake sturgeon (Acipenser fulvescens) populations (Fisheries Branch files, eastern region).

Table 1. Description of Whiteshell Intensive Use Zone Lakes

Zone	Lake	Area (ha)	Depth (m) Mean	Depth (m) Max.	TDS (mg/l)	MEI[2]	Game fish species[3]
Falcon-West Hawk Lakes							
	Falcon[1]	1466	14.6	25.0	80	5.5	Wa, pi, pe, ba
	West Hawk	1492	51.6	112.8	60	1.2	Wa, pi, pe, ba, tr
	Star	143	3.2	8.5	80	25.0	Wa, pi, pe, ba
	Caddy	289	4.0	7.6	72	18.0	Wa, pi, pe, ba
Brereton Lake	Brereton[1]	882	4.1	6.4	50	12.2	Wa, pi, pe
Jessica Lake	Red Rock	132	2.4	4.3	100	41.7	Wa, pi, pe
	Jessica	815	2.0	4.9	100	50.0	Wa, pi, pe
	White	637	2.3	7.0	104	45.2	Wa, pi, pe
Big Whiteshell Lake	Big Whiteshell[1]	1716	4.1	8.2	62	15.1	Wa, pi, pe
Betula Lake	Betula	521	1.8	6.7	82	45.6	Wa, pi, pe
Nutimik Lake	Nutmik[1]	637	11.9	32.3	80	6.7	Wa, pi, pe, ba, mo, st, sa
	Dorothy	1145	11.0	29.8	76	6.9	Wa, pi, pe, ba, mo, st, sa
	Eleanor	934	7.6	26.8	62	8.2	Wa, pi, pe, ba, mo, st, sa
Pointe du Bois	Winnipeg R.	-	-	-	-	-	Wa, pi, pe, ba, mo, st, sa

- indicates datum not available.
[1] included in 1982-1983 angler surveys
[2] metric units ($mg \cdot l^{-1}, m^{-1}$)
[3] legend to species: wa - walleye, pi - northern pike, pe - yellow perch, ba - smallmouth bass, tr - lake trout, mo - mooneye, st - lake sturgeon, sa - sauger.

Source: Fisheries Branch files, eastern region.

Significance of Angling in Whiteshell Park

Whiteshell Park plays a significant role in providing outdoor recreational opportunities in southern Manitoba. Wang (1980) estimated that 800 000 people, including 560 000 in the city of Winnipeg, lived within 200 km of the park. A variety of recreational facilities are present in Whiteshell. These include a golf course, riding stables, tennis courts, hiking trails, a downhill ski resort, cross-country ski trails, beaches, large numbers of campsites and cottages, commercial lodges, marinas, and other facilities. At the same time, Whiteshell is a natural park that is to be Manitoba's key recreational area within the Precambrian Shield (Manitoba Department of Natural Resources 1983b).

Angling is a major recreational activity in Whiteshell Park. Past surveys have shown that cottagers and campers were the largest user groups in the park. The combined percentage varied from 62% in 1968, to 72% in 1970, to 78% in 1973 (Wang 1980). Fishing [angling] was high on the list of most frequent recreational activities for both of these user groups. Wang (1978) found that fishing was the second most popular activity after swimming for both transient and seasonal campers. Eighty-seven percent of all seasonal campers participated in fishing; the rate for transient campers was 51%. Paton (1975) stated that 16% of day-users participated in fishing, which was the fourth most popular recreational activity among this group.

Manitoba Department of Natural Resources (1983b) stated that nearly one third of angling done in Manitoba is done in Whiteshell. This information is based on surveys conducted between 1967 and 1972 (Nelson 1975). A joint federal-provincial survey done in 1980 estimated that 330 000 angler-days were expended in Whiteshell and Nopiming Parks combined. This represented 13% of all angler-days expended in the province (Manitoba Department of Natural Resources 1984). These surveys demonstrate the significance of the Whiteshell fishery.

Limitations

Research conducted for this project was limited in scope. This report does not attempt to provide overall management plans for the four lakes studied. The fish populations were not directly surveyed or inventoried. However, this research does address management of the fisheries based on information received from anglers during the course of the surveys. Catch per unit effort was used as the primary indication of angling quality. As is the case with most studies of natural resource management, some questions were answered satisfactorily, some were not, and still other questions were raised. Some of these additional questions to be addressed are suggested later in this report.

Summary

In Whiteshell, as in much of southern Manitoba, a limited supply of angling opportunities exists. Some management tools are available to alleviate to some degree the supply-demand imbalance. Habitat maintenance and enhancement programs can sustain or improve present fish stocks in some situations. Stocking fish, particularly to introduce species, or where natural reproduction is inadequate may be effective in some cases.

Natural resource management almost invariably implies management of both the resource and the people using that resource. This is increasingly true for fisheries management in the Whiteshell intensive recreation zones. Possession limits and seasons may need to be reviewed to restrict harvest of the limited fish resource. New 'hi-tech' methods that anglers increasingly use should be evaluated, and their impact on fisheries determined. 'Catch and release' practices and use of barbless hooks have been promoted in past years to extend the angling opportunities derived from the limited quantity of fish available. The desirability of all species of fish, and the techniques for catching non-traditional species can be promoted, to better utilize the fish resource.

Chapter II of this report outlines the methods used in surveying anglers. Chapter III presents the results of

these surveys, and compares these findings with the results of surveys conducted on the same four lakes in the past. Significant similarities, changes, and trends through time are noted.

Chapter IV summarizes the results of the research and comments on implications for management of the four lakes. In Chapter V, the general management problems and tools mentioned above are discussed, and specific recommendations are made.

Chapter II

METHODS

Survey Methods

Data for this study were collected by means of angler field surveys, as well as from Fisheries Branch files. The field surveys consisted of daily creel censusses conducted on four lakes within the intensive recreation zones of Whiteshell Provincial Park.

Falcon and Big Whiteshell Lakes were surveyed in 1982, while Nutimik and Brereton Lakes were surveyed in 1983. The criteria to choose the four lakes were:

1. preference given to lakes with high angling effort (as estimated from personal observations and experiences, from local contacts, and from past surveys);
2. preference given to those lakes where data collected enhanced or supplemented other on-going projects;
3. preference given to lakes providing fewer logistical problems (vis-a-vis accommodation and travel costs)
4. preference given to those lakes where information existed from past surveys.

The period studied on each lake extended from the opening day of the angling season on the third Saturday in May until Labour Day, the first Monday in September. The period

studied was divided into three strata. These strata were chosen to maximize precision, based on the results of previous similar surveys. The three strata were:

Stratum 1: Opening Weekends - days falling on the Saturday or Sunday of the opening weekend, or on the three days of the following Victoria Day weekend.

Stratum 2: Days falling on weekends or holidays, other than those days included in stratum 1.

Stratum 3: Weekdays - days falling on weekdays, but not including holidays.

For each of the two lakes surveyed each year, a random sample of days was chosen from each stratum. This random sample was chosen using a table of random numbers, and with the exception of the sample for stratum 1, was subject to the restriction that the two lakes being surveyed could not be censussed on the same day. Each lake was censussed on 21 different days during the study period. The Statistical and Computational Methods section describes how the 21 days were allocated among the three strata.

A roving creel census technique was employed on each of the days to be censussed. Appendix A contains a review of this technique. On each day, the lake was circled once per hour from 6:00 a.m. until dark, using a boat and a 20 H.P. Mercury outboard motor. On each tour of the lake, every boat containing anglers was interviewed. Licenses were not checked, and no enforcement functions were practised during the course of the survey. The benefit of any enforcement

activity may have been more than offset by the subsequent lack of co-operation by anglers.

The following information was recorded at each interview:

1. A distinctive characteristic of the boat or the party being interviewed. This enabled later accumulation of data for a given party.
2. The number of active anglers present in the boat.
3. The time of the interview.
4. The time the party began angling, if this was the party's first interview, or if angling activity had been interrupted.
5. The type(s) of license (resident, non-resident, three-day non-resident, other) held by the anglers.
6. The type(s) of accommodation used by the anglers (cottage, lodge, campground, other - for 1983, campground was further subdivided into transient campground and seasonal campground). Cottage accommodation included anglers who were renters or guests at a cottage on the lake being censussed.
7. The number of fish of each species caught.
8. The number of fish of each species kept.
9. The fork length of each fish kept (subject to angler co-operation, time available, and weather suitable for docking together of the two boats).

From the above information, daily summaries were prepared containing the following data:

1. The number of angling parties (boats) that were present on the lake that day.
2. The number of angler-days expended (i.e. the number of different anglers present during the day).
3. The number of angler-hours expended.
4. The number of fish caught.

5. The number of fish kept.

6. The number of each different species of fish caught.

7. The number of each different species of fish kept.

8. All of the above information (1 through 7) for each of the accommodation types available on the lake (cottage, lodge, campground, other).

9. All of the above information (1 through 7) for each type of license available (non-resident, 3-day non-resident, resident, other).

Statistical and Computational Methods

The production potential of each lake's ichthyomass was computed using Ryder's (1965) morphoedaphic index (MEI):

$$MEI = \frac{\text{Total Dissolved Solids (TDS) (in mg/l)}}{\text{Mean Depth (in m)}}$$

Appendix B contains a review of Ryder's method. TDS data were obtained from average annual values as collected by Environmental Management Services Branch. Mean depths were obtained from lake survey files of Fisheries Branch, eastern region. Ryder's (1965) relationship for north-temperate lakes (converted to metric units) was then used to calculate potential yield from MEI:

$$\text{Potential Yield } (kg.ha^{-1}.yr^{-1}) = 1.382\ [MEI(mg.l^{-1}.m^{-1})]^{0.44610}$$

The total biomass of harvest was estimated by using a fork length-weight relationship independently measured for each species in each lake (obtained from the files of Fisheries Branch, eastern region). The individual lengths of each species in each lake, as measured during the angler surveys, were converted to estimates of weights by interpolation from the relationship.

Allocation of the days to be sampled among the three strata for each lake was accomplished using the Neyman allocation method, as reported by Cochran (1963). This method maximizes precision of data collected by taking

larger samples in a given stratum if either the stratum is larger, or if the stratum is more variable internally. For this research project, internal variability was estimated in 1982 from similar surveys in the past. In 1983, the variances from the 1982 surveys were used. By using these methods, the sampling rates were changed slightly from 1982 to 1983 (Table 2).

TABLE 2

Sampling Rates (Number of Days Censussed / Number of Days in Stratum) by Stratum for the Four Lakes Surveyed.

		Sampling Rates			
Year	Lake	Stratum 1	Stratum 2	Stratum 3	Total
1982	Falcon	3/5	10/33	8/77	21/115
1982	Big Whiteshell	3/5	10/33	8/77	21/115
1983	Brereton	3/5	11/33	7/77	21/115
1983	Nutimik	3/5	11/33	7/77	21/115

Sampling percentages varied widely; from 60% (3/5) in stratum one, to nine percent (7/77) in 1983 in stratum three. This phenomenon occurred because of the much higher anticipated variances in the first stratum. This stratum was composed of the first two weekends of the angling season. Very large numbers of anglers are sometimes present during this time, thus accounting for the high variability.

Low variances experienced between weekdays justified the relatively low sampling percentages for the third stratum. Allocation very close to the optimum was achieved, as calculated by using actual variances experienced during the surveys.

Estimates of the precision of parameters measured were calculated according to methods described by Cochran (1963) for stratified random sampling techniques. Cochran's (1963) methods for approximating the number of degrees of freedom for the t-value from the table of Student's 't' distribution were also used. This method recognizes that variances vary from stratum to stratum. Except for large sample sizes ($n>60$) the resulting t-value is greater than two, which is the value often used to multiply by the standard error when calculating 95% confidence limits.

Regression analysis and computation of correlation coefficients for relationships between parameters were calculated according to methods described by Snedecor and Cochran (1967).

Analysis of variance techniques were also used to test for equality of some parameters between lakes. This was accomplished using methods for two-way analysis of variance with unequal cell numbers, as described by Kleinbaum and Kupper (1978).

Hypotheses tested using this method:

1. H_0: Effort per unit area was equal for the four lakes surveyed,

   H_1: Effort per unit area was not equal for the four lakes surveyed,

2. H_0: Catch per unit effort was equal for the four lakes surveyed,

   H_1: Catch per unit effort was not equal for the four lakes surveyed.

Analysis of variance techniques were used to test for increasing or decreasing trends through time for some parameters. These were calculated using methods from Li (1964).

Hypotheses tested using this method:

For Falcon, Brereton, and Nutimik Lakes, each of the following parameters were tested for a consistent increase or decrease over the time period for which records from angler surveys exist:

i.e. H_0: $\beta = 0$,
H_1: $\beta \neq 0$ for the relationship:
$y = a + \beta (x)$, where
y is parameter measured,
x is time (year).

3 - 5. Effort per unit area;

6 - 8. Catch per unit effort;

9 - 11. Yield;

For Falcon Lake:

12. Percentage of walleye in the anglers' creel,

13. Percentage of northern pike in the anglers' creel,

14. Percentage of smallmouth bass in the anglers' creel,

For Brereton Lake:

15. Percentage of walleye in the anglers' creel,
16. Percentage of northern pike in the anglers' creel,
17. Percentage of yellow perch in the anglers' creel;

For Nutimik Lake:

18. Percentage of sauger in the anglers' creel,
19. Percentage of walleye in the anglers' creel,
20. Percentage of northern pike in the anglers' creel,
21. Percentage of lake sturgeon in the anglers' creel.

22. The relationship between yield and effort was tested for significant correlation:

i.e. H_0: $\beta = 0$,
H_1: $\beta \neq 0$ for the relationship:
$y = \alpha + \beta \ln (x)$, where
y is yield,
x is effort.

The following relationships were tested for significant correlation:

i.e. H_0: $\beta = 0$
H_1: $\beta \neq 0$ for the relationship:
$\ln (y) = \alpha + \beta \ln (x)$, where
y is the first parameter in the relationship
x is the second parameter in the relationship.

23. Catch per unit effort vs. effort;

24. Catch per unit effort vs. exploitation level.

All of the above computations were accomplished using a Texas Instruments model 99 4A home computer. The computer programs were written by the author specifically for this research project.

Chapter III

RESULTS OF THE FIELD SURVEYS

This chapter presents the results of the angler surveys conducted in 1982 and 1983 on the four study lakes. Data is also presented from surveys done on these lakes in the past. Comparisons are made and trends, similarities and/or differences are noted.

Summaries of the 95% confidence intervals of statistics calculated from the 1982 and 1983 surveys on the four lakes, are contained in Appendix D.

Angling Effort

More angling effort was expended on Big Whiteshell Lake than on any other Lake. (Table 3). Falcon Lake supported the least angling effort.

TABLE 3

Estimates of Angling Effort Expended on the Four Lakes Surveyed. Confidence Intervals are X $\pm t_{0.05}N(SE)$.

Lake	Angler-days	Angler-hours
Falcon	4138 ± 1055	8250 ± 1820
Big Whiteshell	6105 ± 1094	14779 ± 2866
Brereton	4593 ± 1096	11590 ± 3225
Nutimik	4985 ± 1070	13922 ± 4088

Comparing effort per unit area facilitates comparison between the lakes. The number of angler-hours/ha expended on Nutimik Lake was higher than the other three lakes (Table 4). Brereton Lake was the next highest, followed by Big Whiteshell Lake, then Falcon Lake.

The highly significant difference ($P=0.01$, F test) between lakes demonstrates that equal effort per unit area was not expended on each lake.

TABLE 4

Estimates of Angling Effort Expended per Unit Area for the Four Lakes Surveyed. Confidence Intervals are $X \pm t_{0.05}N(SE)$.

Lake	Area(ha)	Effort[1](Angler-hours/ha)
Falcon	1466	5.6 ± 1.2
Big Whiteshell	1716	8.6 ± 1.7
Brereton	882	13.1 ± 3.7
Nutimik	637	21.9 ± 6.4

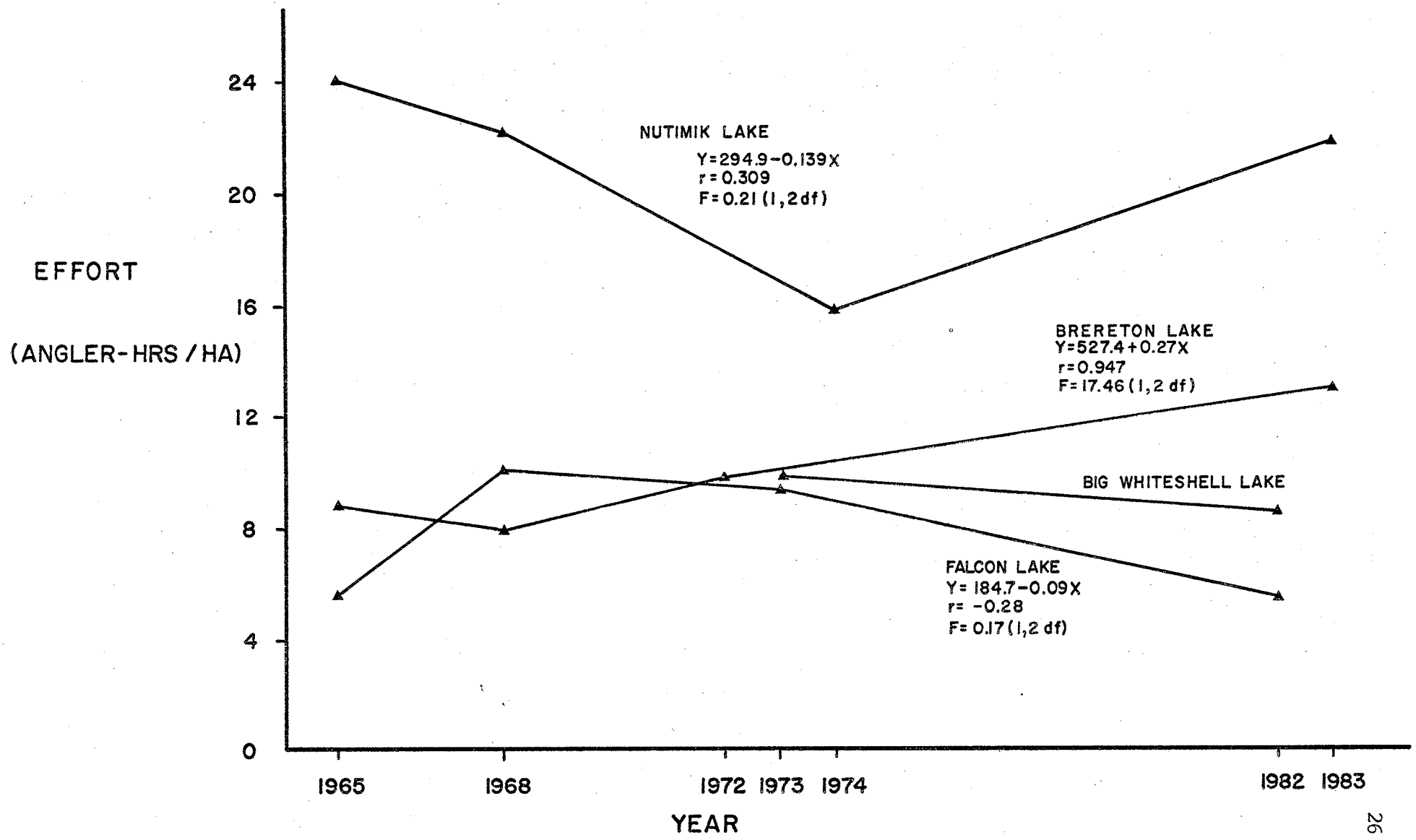
[1] Effort per unit area between the four lakes was significantly different (F=10.55**, d.f.=3,76).

Angler field surveys conducted in the past (Andrews 1965; Dennehy and Andrews 1969; Sorochan and Andrews 1969; Miller and Andrews 1972; Fisheries Branch files, eastern region) also made estimates of effort per unit area. The confidence intervals around some of the estimates from these past surveys are wide or unavailable, and some of the methods and/or analytical techniques used are not well documented. Nevertheless, the past information is useful.

Effort per unit area on Nutimik Lake was consistently higher than on the other three lakes surveyed (Figure 3).

No statistically significant increase or decrease in effort over the time period covered by the surveys was noted for any one lake. However, effort did increase on Brereton Lake. The calculated statistical value was only slightly less than the significant value (P = 0.05, F test).

Figure 3 Effort per Unit Area as estimated by Past Angler Surveys for the Four Lakes Surveyed.



Relatively constant effort occurred over time in Falcon, Big Whiteshell and Nutimik Lakes. Effort in Brereton Lake appeared to increase.

Non-Resident Angling

All anglers contacted during the surveys were categorized into one of the following four groups:

1. Holder of a non-resident (non-Canadian) seasonal angling license,
2. Holder of a non-resident (non-Canadian) 3-day angling license,
3. Holder of a resident (Canadian resident) angling license,
4. Other. This latter category included children 16 and under, senior citizens, and others who admitted to not holding a valid angling license. This group was included with holders of resident angling licenses for the purpose of analyzing percentages of non-resident angling activity.

Canadian residents constituted a large majority of anglers using the four fisheries (Table 5).

TABLE 5

Percentage of Anglers Holding Non-resident Angling Licenses on the Four Lakes Surveyed.

Lake	% Non-resident Licenses	# Non-resident Licences Encountered
Falcon	2.2%	13
Big Whiteshell	7.5%	81
Brereton	2.7%	19
Nutimik	3.2%	25

The estimated percentage of non-resident anglers using Big Whiteshell Lake was higher than for the other three lakes. Even on Big Whiteshell lake, however, the percentage was low when compared to the estimated 92.5% of resident anglers present.

Angling Categorized by Accommodation Type

Anglers contacted during the survey was categorized by the accommodation type they used. These types were:

1. Cottages. Anglers who were renters or guests at a cottage were included in this type.
2. Lodges.
3. Campgrounds. This was further subdivided into transient campgrounds or seasonal campgrounds for Brereton and Nutimik Lakes only (1983 surveys).
4. Others. Primarily day-users, those not staying overnight in Whiteshell Park, were included in this type.

The largest groups of anglers were those staying at either cottages or campgrounds (Figure 4). The proportion of each varied, but the combination of these two accommodation types accounted for at least 70% of anglers (on Brereton Lake), and as much as 88% of anglers (on Falcon Lake). The percentage of anglers who were day-users, or who stayed at lodges, was lower than the percentage of anglers staying in cottages or campgrounds for all four lakes.

The following observations may be made on an individual lake basis:

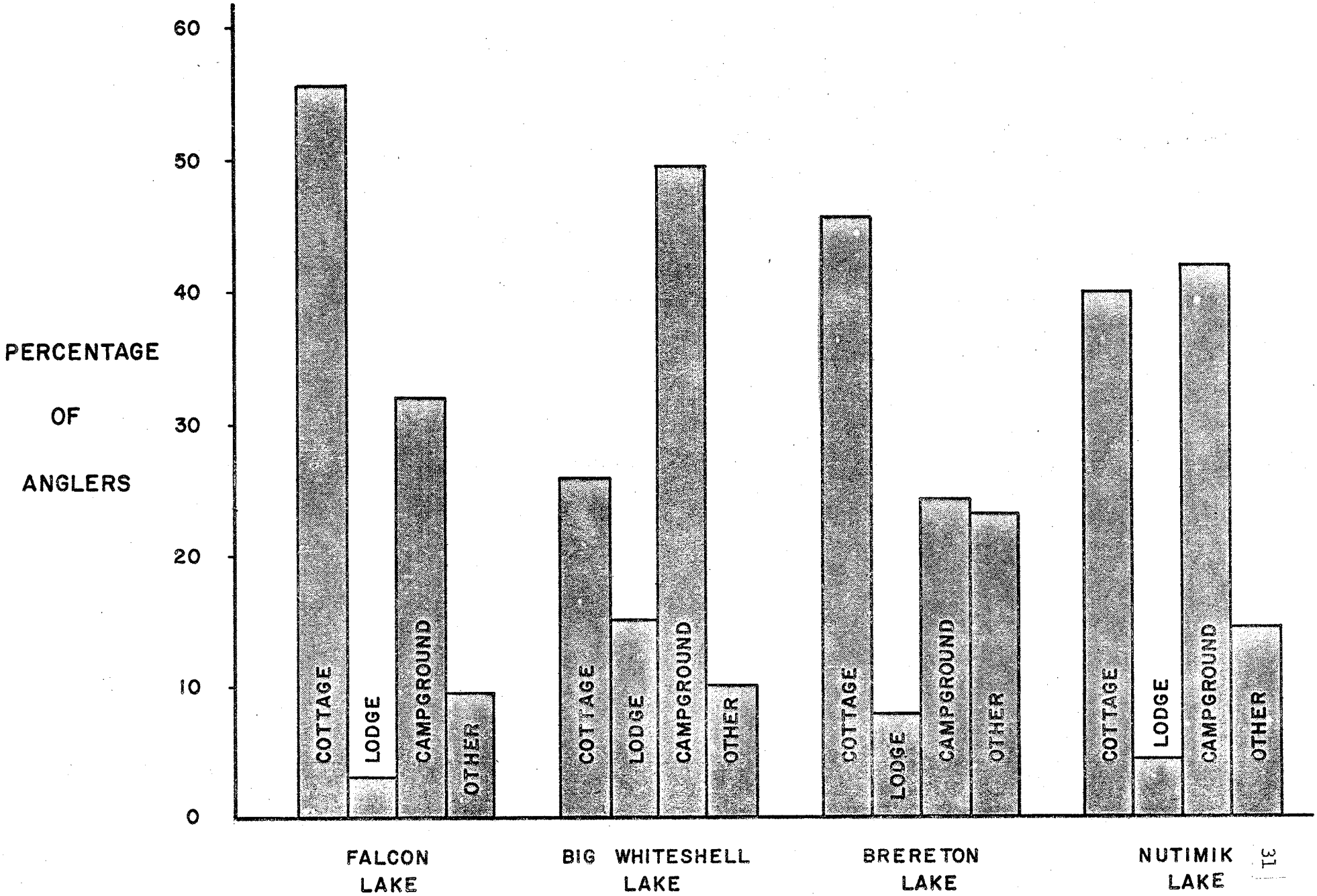
Falcon Lake: relatively high use by anglers from cottages.

Big Whiteshell Lake: relatively low use by anglers from cottages, relatively high use by anglers from campgrounds, relatively high use by anglers from lodges.

Brereton Lake: relatively high use by day-use anglers.

Nutimik Lake: relatively high use by anglers from campgrounds.

Figure 4 Percentages of Anglers Using Each Accommodation Type on the Four Lakes Surveyed.



Overall Angling Success

A major objective of this research project was to measure the angling success experienced by anglers on the four lakes surveyed. Catch per unit effort is a key statistic in determining angling quality and in guiding fisheries management.

Variation existed in catch per unit effort from lake to lake (Table 6). A statistically significant difference ($P=0.05$, F test) existed in catch rates enjoyed by anglers between some of the lakes. Anglers on Brereton and Big Whiteshell Lakes enjoyed the highest catch per unit effort. Falcon Lake showed the lowest rate, while Nutimik Lake was intermediate.

TABLE 6

Rates of Catch per Unit Effort Experienced by Anglers on the Four Lakes Surveyed.

Lake	Catch per Unit Effort[1] (Fish Caught / Angler-Hour)
Falcon	0.27
Big Whiteshell	0.41
Brereton	0.42
Nutimik	0.35

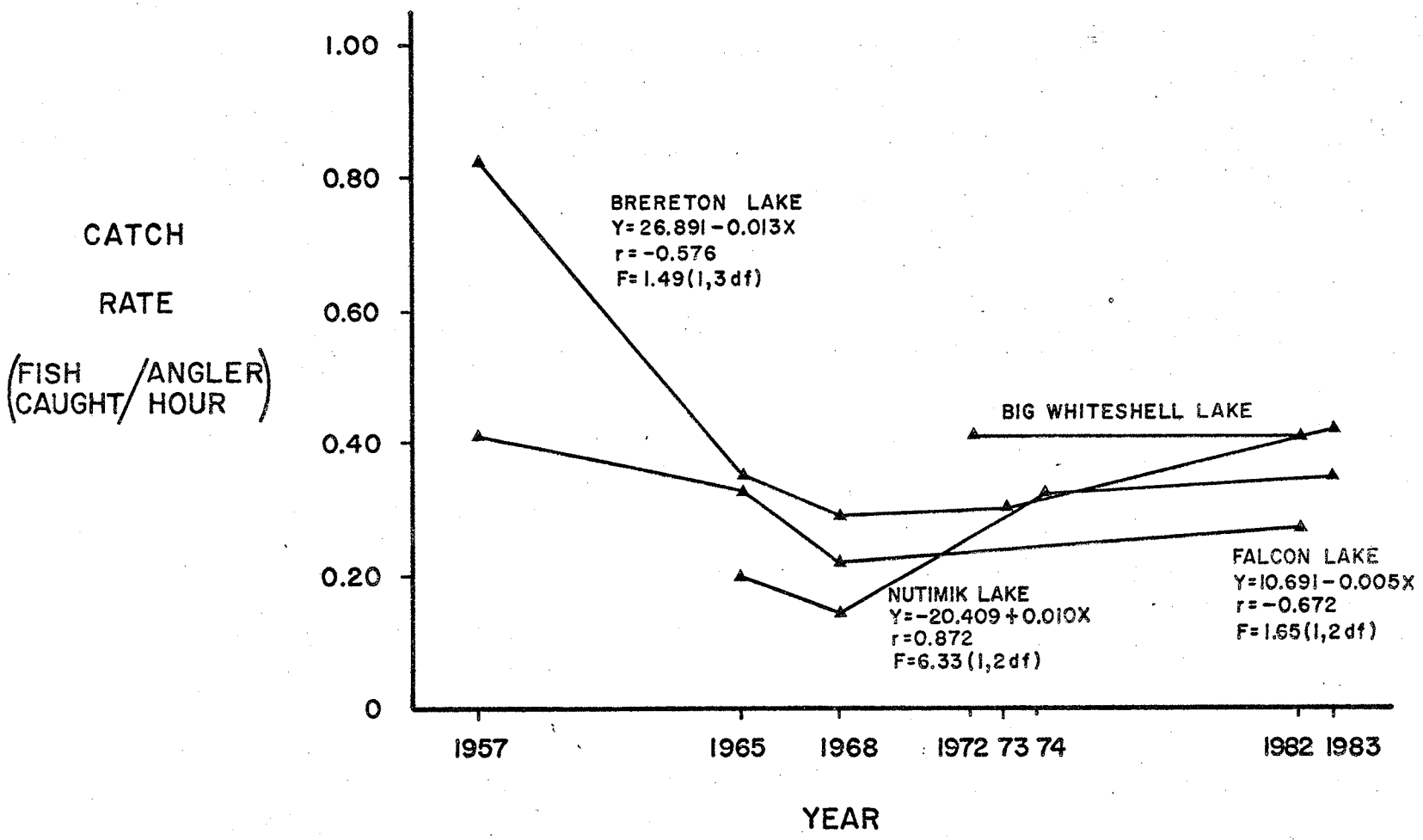
[1] Catch per unit between the four lakes was significantly different ($F = 3.00^*$, d.f. = 3,76).

Catch per unit effort was also measured by angler field surveys done in past years (Fedoruk 1957; Andrews 1965; Dennehy and Andrews 1969; Sorochan and Andrews 1969; Miller and Andrews 1972; Fisheries Branch files, eastern region). Most of the catch rates measured were in the range of 0.25 to 0.50 fish caught per angler-hour, with the exception of a high value for Brereton Lake in 1957, and two low values for Nutimik Lake in the 1960's (Figure 5). No statistically significant increase or decrease (P=0.05, F test) in catch per unit effort over the time period covered by the surveys was noted for any one lake. In more general terms, success rates declined during the 1960's and showed a modest increase during the 1970's and 1980's. The higher values measured in 1957 have not been maintained into the post-development era of Whiteshell Park.

A wide range of factors may account for the apparent year-to-year changes in catch rates. These include:

- variations in measurement techniques between angler surveys,
- random variations associated with creel census sampling techniques,
- changes in the type of angler using the fisheries.
- the emergence of 'hi-tech' angling gear and techniques,
- annual variations in weather or water levels,
- changes in either water quality or the eutrophication levels of the lakes,
- changes in year class strengths of game fish species.

Figure 5 Catch per Unit Effort as Estimated by Past Angler Surveys for the Four Lakes Surveyed.



The significance of catch per unit effort in fisheries management in Whiteshell intensive recreation zone lakes is discussed in more detail in Chapter V.

Angling Success by Different Groups

A comparison of resident and non-resident license holders on Big Whiteshell Lake indicated that non-residents enjoyed a higher catch per unit effort (Table 7).

TABLE 7

Comparison of Catch per Unit Effort for Resident License Holders and Non-resident License Holders on the Four Lakes Surveyed.

	Catch per Unit Effort			
	Fish caught/ Angler-Hour	Fish caught/ Angler-Day	Hours angled/ Angler-Day	#Anglers Surveyed
Falcon				
Resident	0.27	0.51	1.9	992
Non-res.	-	-	-	13
Big Whiteshell				
Resident	0.40	0.94	2.3	1394
Non-res.	0.48	1.65	3.5	81
Brereton				
Resident	0.42	1.05	2.5	985
Non-res.	-	-	4.0	19
Nutimik				
Resident	0.35	0.99	2.8	971
Non-res.	-	0.76	-	25

- indicates datum not available

Non-residents enjoyed a higher success rate than resident anglers and angled for a longer period of time each day. Consequently, they caught a larger number of fish per angler-day. This result was not verified on Nutimik Lake. This apparent contradiction may have been due to the low numbers (25) of non-residents interviewed on this lake during the course of the survey, and the resulting low precision of estimates made from such information. Even fewer non-residents were contacted on Falcon and Brereton Lakes.

In general non-residents were more successful anglers, and angled more fish than residents. On all four lakes, anglers from cottages experienced a higher catch per unit effort than anglers using campgrounds (Figure 6). On Big Whiteshell Lake, campers caught more fish per angler-day than cottagers because on average they angled for more time per angler-day (Table 8). Such was not the case for the other three lakes, where fish angled per angler-day remained higher for cottagers than for campers. As shown earlier in this report, most anglers used either cottages or campgrounds.

Figure 6 Catch per Unit Effort by Accommodation Type for the Four Lakes Surveyed.

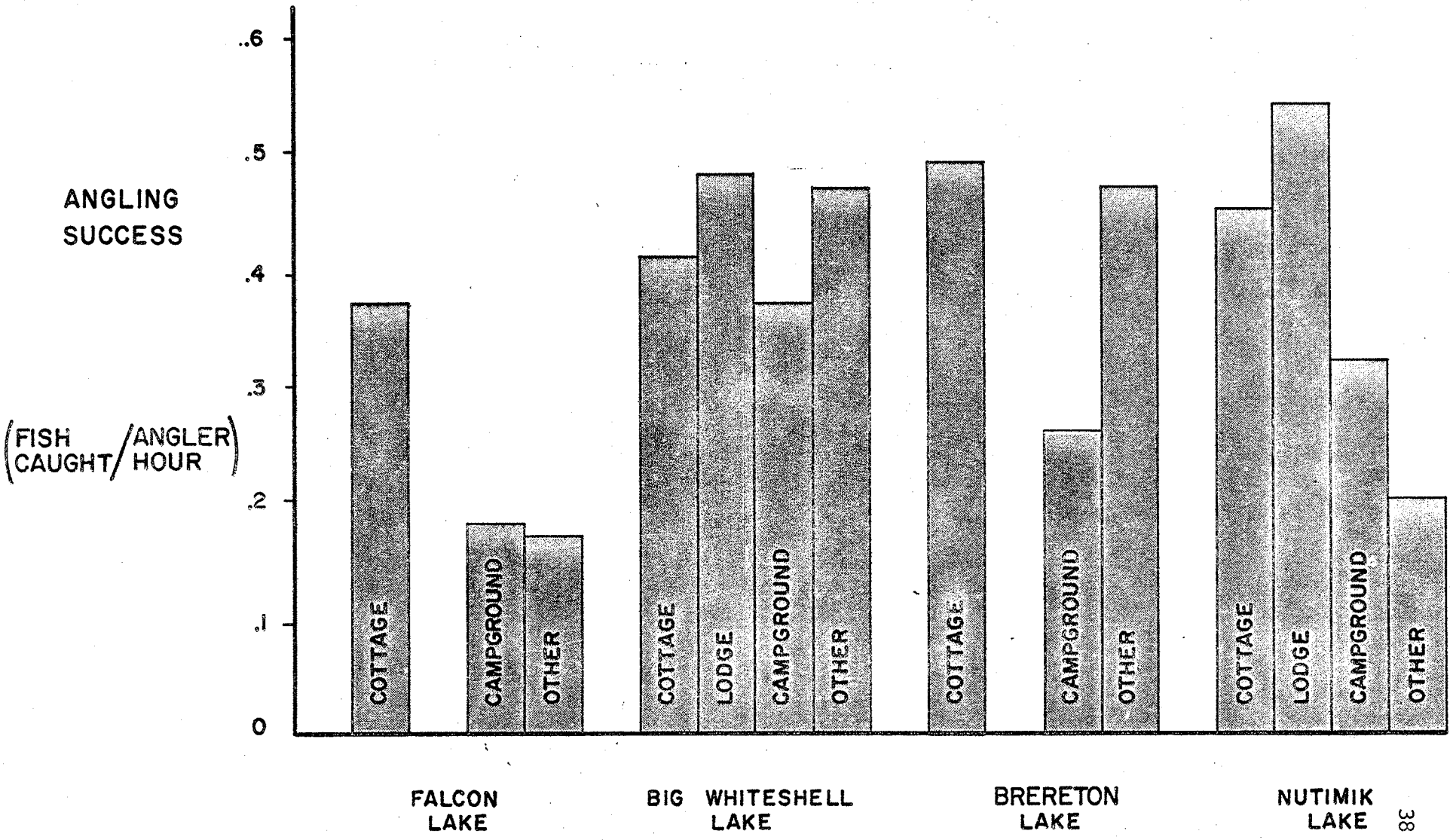


TABLE 8

Catch per Unit Effort by Accommodation Type for the Four Lakes Surveyed.

Lake, Accommodation	Catch per Unit Effort: Fish Caught/ Angler-hour	Fish Caught/ Angler-day	Hours Angled/ Angler-day
Falcon			
Cottage	0.37	0.68	1.9
Lodge	-	-	3.3
Campground	0.18	0.31	1.7
Other	0.17	0.53	3.2
Big Whiteshell			
Cottage	0.41	0.71	1.7
Lodge	0.48	1.33	2.8
Campground	0.37	0.88	2.4
Other	0.47	1.82	3.9
Brereton			
Cottage	0.49	0.83	1.7
Lodge	-	1.27	-
Campground	0.26	0.68	2.7
Other	0.47	1.81	3.9
Nutimik			
Cottage	0.45	1.18	2.6
Lodge	0.54	1.21	2.2
Campground	0.32	0.84	2.7
Other	0.20	0.76	3.8

- indicates datum not available

No consistent pattern emerged for anglers in the 'other' category (primarily days-users in Whiteshell). The angling success was lower for day-users than for any other group on Falcon and Nutimik, but relatively high on Big Whiteshell and Brereton Lakes. The high rate for these two lakes is significant. Day-users spent more time angling per angler-day than did other groups, thus harvesting a substantially higher number of fish. This apparently more dedicated type of angler may also have been more knowledgeable and better equipped, and thus more efficient. As mentioned earlier in this report, day-users also comprised a significant fraction of all anglers on Brereton Lake.

For the two lakes where estimates could be made, Big Whiteshell and Nutimik, anglers from lodges enjoyed a higher catch rate than did any other group. The low numbers of lodge users encountered on the other two lakes did not allow reliable estimates of catch rate.

Fish Yields

The total harvest of fish varied widely from lake to lake. Most of the harvests on Falcon and Brereton Lakes were composed of walleye (Table 9). Northern pike was the most abundant species by weight in the anglers' creel on Big Whiteshell Lake. The harvest on Nutimik Lake was more diverse. Although the numbers of lake sturgeon harvested were low, this species comprised a larger proportion of the harvest by weight than any other species.

TABLE 9

Estimated Fish Harvests by Lake and by Species for the Four Lakes Surveyed.

	Falcon Lake(kg)	Big Whiteshell Lake (kg)	Brereton Lake(kg)	Nutimik Lake(kg)
Walleye	823	1489	2543	470
Pike	439	2573	862	266
Sauger	0	0	0	459
Mooneye	0	0	0	126
Smallmouth Bass	-	0	0	108
Lake sturgeon	0	0	0	516
Perch	-	-	119	15
Other[1]	99	71	-	-
Total	1361	4133	3524	1960

-indicated datum not applicable.
1 For Falcon and Big Whiteshell Lakes, all species except walleye and northern pike are included in this category.

Anglers from cottages angled sizeable proportions of the harvest on each of the four lakes (Table 10). Campers also harvested significant amounts on all lakes except Falcon Lake. Harvest by anglers staying at lodges was high on Big Whiteshell Lake, while day-users harvested large amounts of fish on Brereton Lake, and to a lesser extent on Big Whiteshell Lake.

TABLE 10

Estimated Annual Fish Harvests by Anglers Using Different Accommodation Types on the Four Lakes Surveyed.

	Falcon Lake(kg)	Big Whiteshell Lake (kg)	Brereton Lake(kg)	Nutimik Lake(kg)
Cottage	962	727	1245	1017
Lodge	38	775	293	104
Transient Camp.	-	-	439	310
Seasonal Camp.	-	-	112	331
All Campground	233	1916	552	642
Other	128	714	1436	198

- indicates datum not available

Yield rather than total harvest is another useful measurement in comparing amounts of fish angled from the four lakes. A wide variation existed, with the yield from Falcon Lake being considerably lower than from the other

three lakes (Table 11). This occurred partly because Falcon Lake experienced the lowest angling effort per unit area (Table 4), and partly because of the lowest catch experienced per unit effort (Table 6). The yield for Brereton represents a very high harvest for that particular lake.

TABLE 11

Estimated Annual Fish Yield for the Four Lakes Surveyed.

	Falcon Lake	Big Whiteshell Lake	Brereton Lake	Nutimik Lake
Harvest(kg/yr)	1361	4133	3524	1960
Area (ha)	1466	1716	882	637
Yield ($kg\ ha^{-1}yr^{-1}$)	0.93	2.41	4.00	3.08

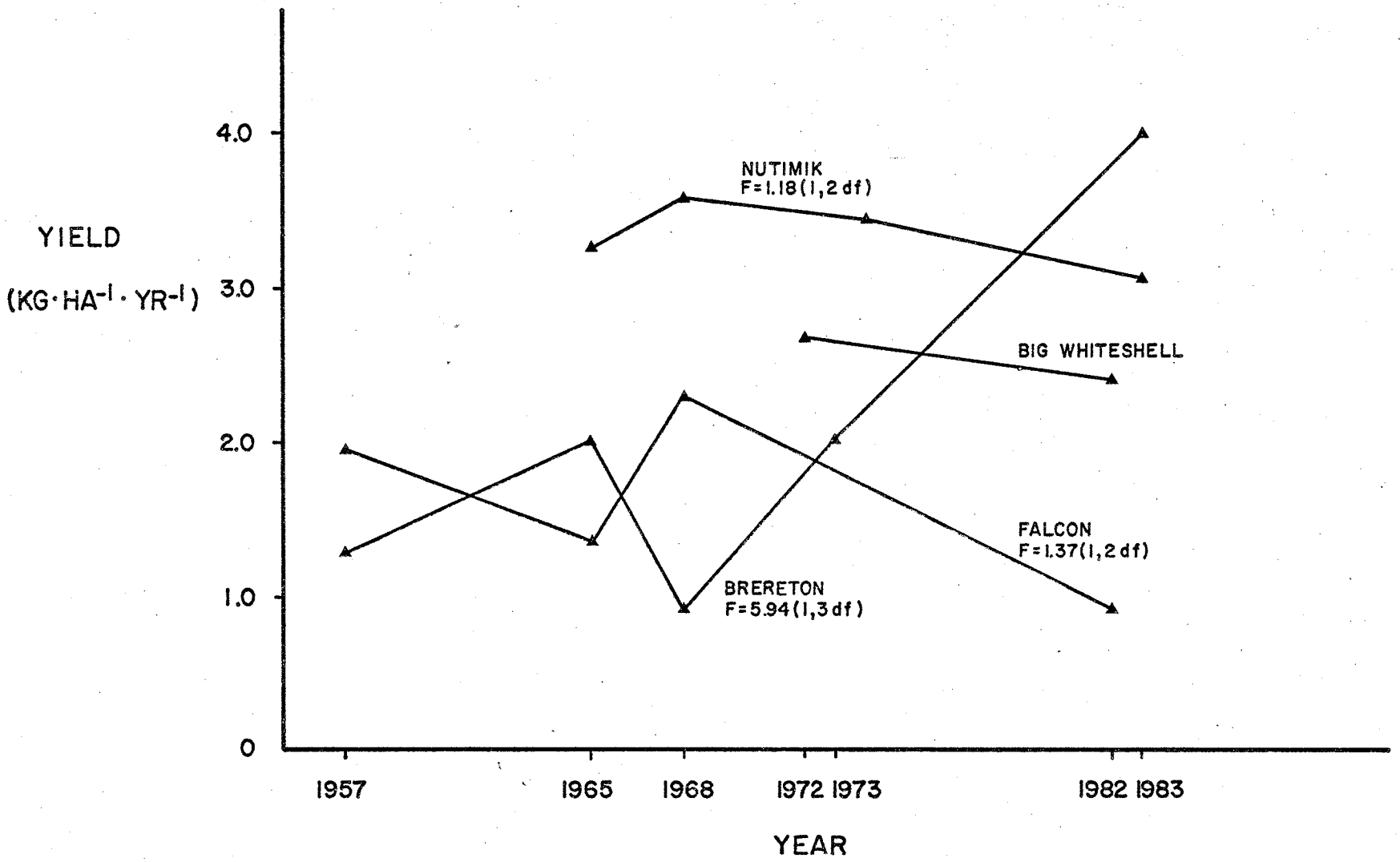
Information was collected from spear fishermen on Falcon Lake using the same methods used for interviewing anglers. Using the same computational methods as for angling data, statistical analysis revealed the following: [confidence intervals are $X \pm \underline{t}_{0.05}\ N\ (SE)$] 100 ± 72 spear fishing days and 164 ± 131 spear fishing hours were expended harvesting 92 ± 71 fish, including 76 ± 63 walleye. These estimates are imprecise but do serve as good first estimates of spear fishing activity on Falcon Lake.

Number of fish harvested per spear-hour was estimated at 0.56, compared to the 0.27 fish per angler-hour experienced by anglers. Reliable information concerning the average size of fish taken by spear fishermen was not collected. If an average size of 0.907 kg (2.0 lbs.) is assumed, the estimate of spear fishing harvest is 83 kg, six percent of the harvest by anglers.

Estimates of angling yield may be derived from past field surveys (Fedoruk 1957; Andrews 1965; Dennehy and Andrews 1969; Sorochan and Andrews 1969; Miller and Andrews 1972; Fisheries Branch files, eastern region). Yield has varied widely over time for Falcon and Brereton Lakes (Figure 7). A decreasing trend suggests itself for Falcon, Big Whiteshell, and Nutimik Lakes. For two of the lakes, these decreases are not statistically significant ($P=0.05$, F test). Insufficient data exist to statistically test for a decrease in yield on the third lake, Big Whiteshell.

The yield on Brereton Lake increased substantially since a very low figure was estimated in 1968. This increase is not statistically significant over the 1957-1983 time period, although such an increase is strongly suggested.

Figure 7 Angler Yields as Estimated by Past Angler Surveys for the Four Lakes Surveyed.



Seasonal Angling Patterns

For Falcon, Big Whiteshell and Brereton Lakes, angling effort was fairly evenly divided between the periods before and after 1 July. On Nutimik Lake, relatively more effort was expended after 1 July (Table 12).* The opening of the lake sturgeon season on 15 June may in part explain this phenomenon.

TABLE 12

Percentage of Effort per Time Period, Percentage of Harvest per Time Period, and Catch per Unit Effort, for May 10 - June 30, and July 1 - September 1 1982 for the Four Lakes Surveyed.

	Falcon Lake(kg)	Big Whiteshell Lake (kg)	Brereton[1] Lake(kg)	Nutimik[1] Lake(kg)
Effort [2]				
May-June	53%	56%	47%	38%
July-Aug	47%	44%	53%	62%
Harvest [3]				
May-June	40%	74%	54%	32%
July-Aug	60%	26%	46%	68%
Catch Rate [4]				
May-June	0.18	0.55	0.44	0.30
July-Aug	0.33	0.24	0.39	0.37

[1] Time periods for Brereton and Nutimik Lakes were May 11 - June 30, and July 1 - September 2 1983.
[2] Percentage of angler-hours expended per time period.
[3] Percentage of number of fish kept per time period.
[4] Number of fish caught per angler-hour.

* This research project was not originally designed to estimate angling in the separate time periods used in this section. Results may be biassed.

On Falcon and Nutimik Lakes, a greater percentage of fish was harvested after 1 July, and the catch rate improved during that time. The opposite was true for Big Whiteshell and Brereton Lakes, especially for the former. For these two lakes, harvest was greater, and angling success was better, during the shorter first time period.

Estimation of Biological Production Potential

The biological production potential of the four lakes surveyed, computed according to Ryder (1965), varied from 2.95 $kg.ha^{-1}.yr^{-1}$ to 4.64 $kg.ha^{-1}.yr^{-1}$ (Table 13).

TABLE 13

Biological Production Potential of the Four Lakes Surveyed.

	Falcon Lake	Big Whiteshell Lake	Brereton Lake	Nutimik Lake
TDS (ppm)	80	62	50	80
Mean depth (m)	14.6	4.1	4.1	11.9
MEI (ppm/m)	5.5	15.1	12.2	6.7
Production Potential ($kg.ha^{-1}.yr^{-1}$)	2.95	4.64	4.22	3.23[1]
Area (ha)	1466	1716	882	637
Production Potential (kg/yr)	4331	7956	3718	2055[1]
Exploitation Level	31%	52%	95%	95%[1]

[1] Production potential for Nutimik Lake is underestimated by using Ryder's (1965) techniques. See text.

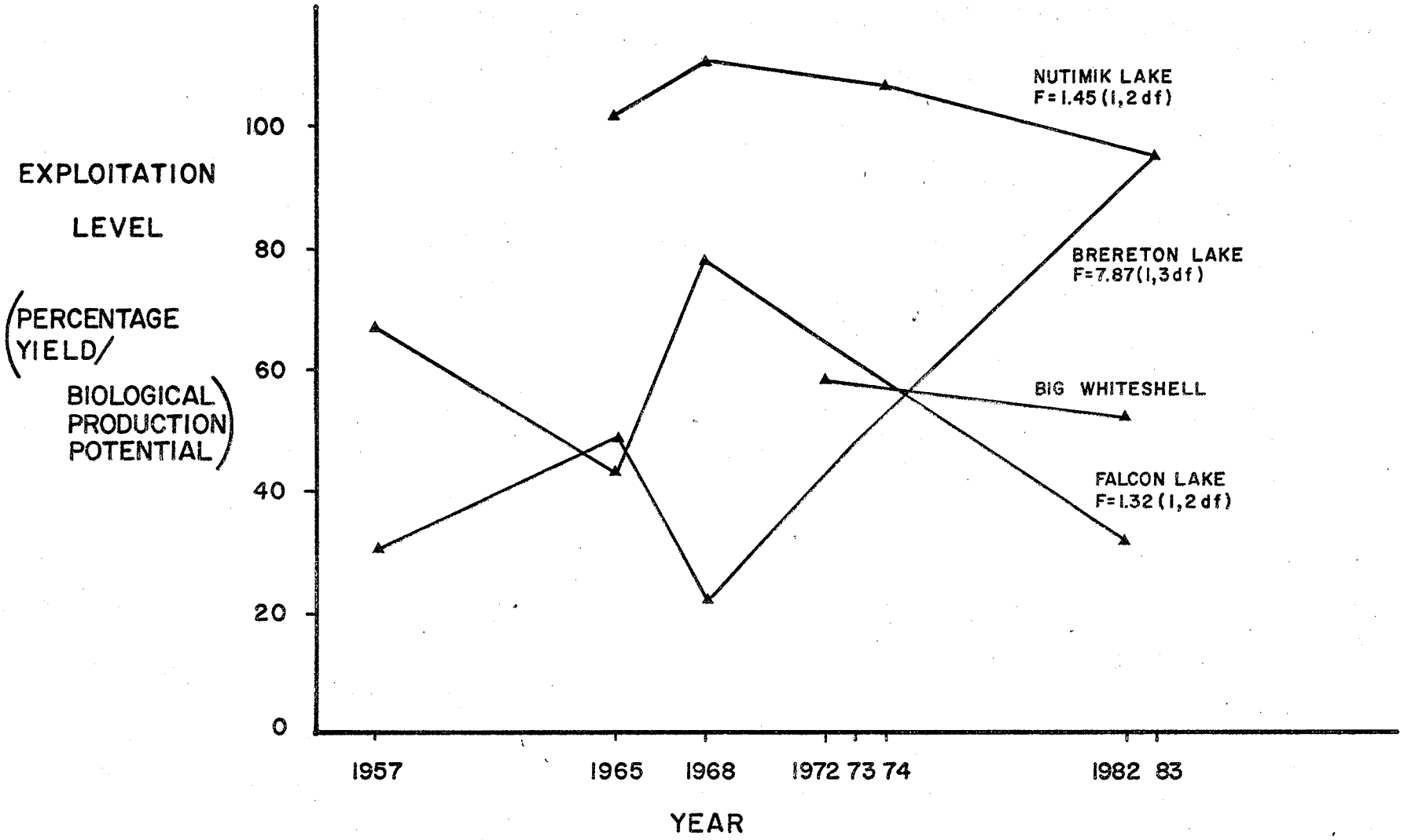
Estimated yield did not exceed production potential (i.e. exploitation level was <100%) for all four lakes. These estimates of annual yield, and hence of exploitation level, may be understated for several reasons: firstly, only

anglers in boats were surveyed; secondly, due to the nature of the roving creel census technique; and thirdly, the time period sampled by the surveys terminated on Labour Day. This latter factor may have been significant for Big Whiteshell Lake, but less so for the other three lakes. In addition, spear fishing harvest was not included in the yield calculations for Falcon Lake. Spear fishing activity was absent or negligible in the other three lakes.

The actual exploitation level for Brereton and Nutimik Lakes probably exceeded 100%. Angler field surveys in the past have not estimated such high exploitation levels for Brereton Lake. The level estimated from past surveys for Nutimik Lake has consistently been slightly higher than 100% (Figure 8). Two factors may invalidate, or justify substantial increase of the biological production potential calculated according to Ryder (1965), in the case of Nutimik Lake.

Firstly, substantial water level fluctuations occur due to the operation of Winnipeg Hydro's electrical generation stations at Seven Sisters Falls, Slave Falls, and elsewhere along the Winnipeg River system. Nutimik lake is a part of this river system (Figure 2), and thus might be classified as a reservoir. These fluctuations were particularly pronounced in the 1979-1981 time period, when major reconstruction took place at the Seven Sisters Falls generation station. Secondly, Nutimik Lake is subject to a high flushing rate. The average exchange time for water in

Figure 8 Exploitation Levels from Past Angler Surveys for the Four Lakes Surveyed.



Nutimik Lake is 1.01 days*

Jenkins (1982) successfully applied Ryder's (1965) methods to a group of reservoirs. However, the reservoirs Jenkins studied were divided such that each sub-group had proportional flushing rates. He found more variability in MEI-reservoir yield relationships than was found for natural lakes. He also found that sport fish yield from reservoirs was higher than for Ryder's original data set of north-temperate lakes. Ryder et al. (1974) specifically mentioned that fluctuating water levels and high flushing rates should exclude the application of Ryder's (1965) method for computing production potential.

Another index in assessing the status of the fisheries on the four lakes is the percentage of each species contained in the angler harvest. On Falcon Lake, the percentages of walleye and northern pike were inconsistent, while the percentage of smallmouth bass remained relatively constant (Figure 9).

The percentages of walleye and northern pike harvested on Big Whiteshell lake changed very little over time (Figure 10).

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* This exchange time is based on an area of 637 ha, a mean depth of 11.9 m (Table 1), and an average flow of 866 m^3/sec (30 565 c.f.s.) at Slave Falls generating station (Saskatchewan - Nelson Basin Board 1972).

Figure 9 Percentage of Each Species in Angler Harvest from Past Angler Surveys on Falcon Lake.

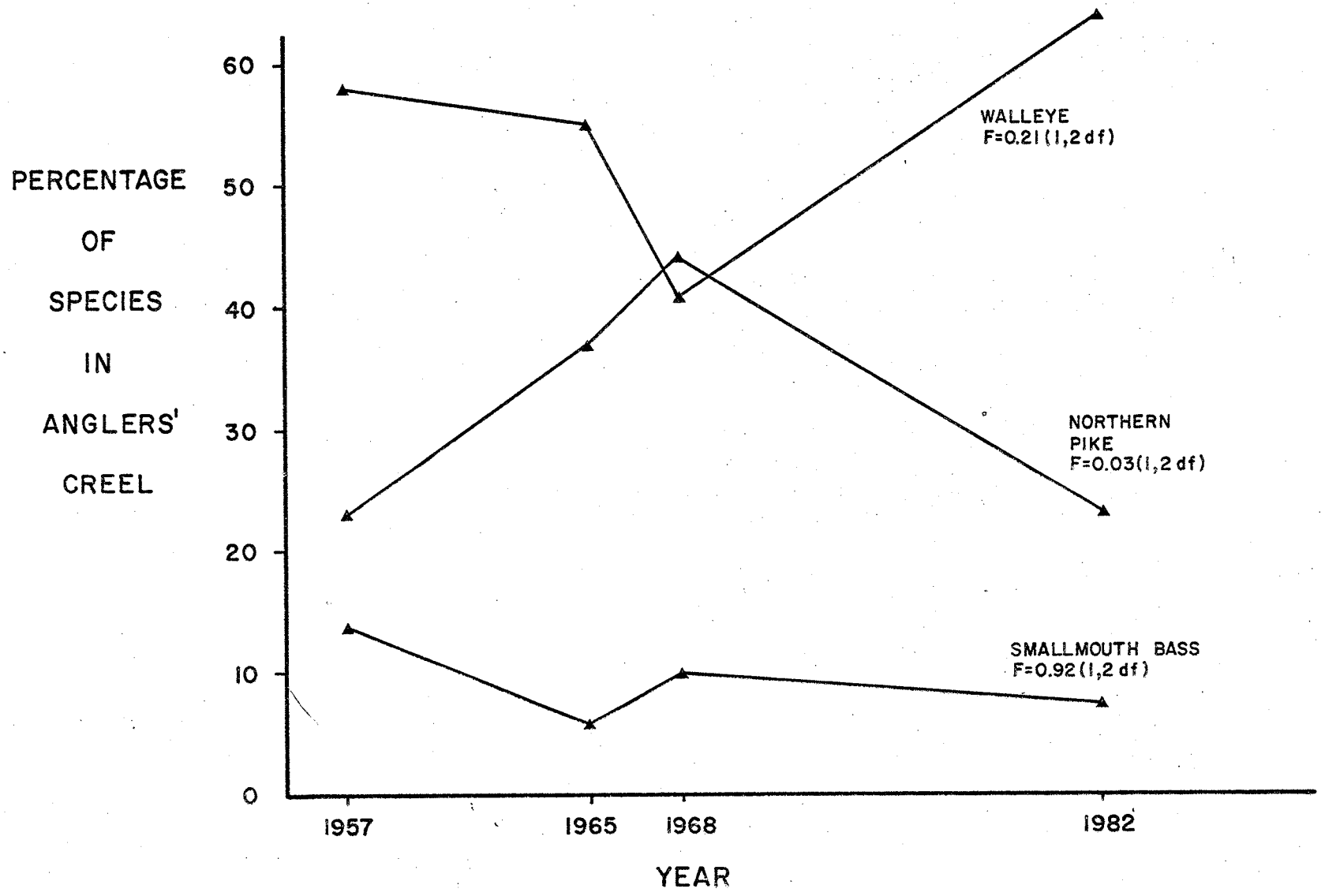
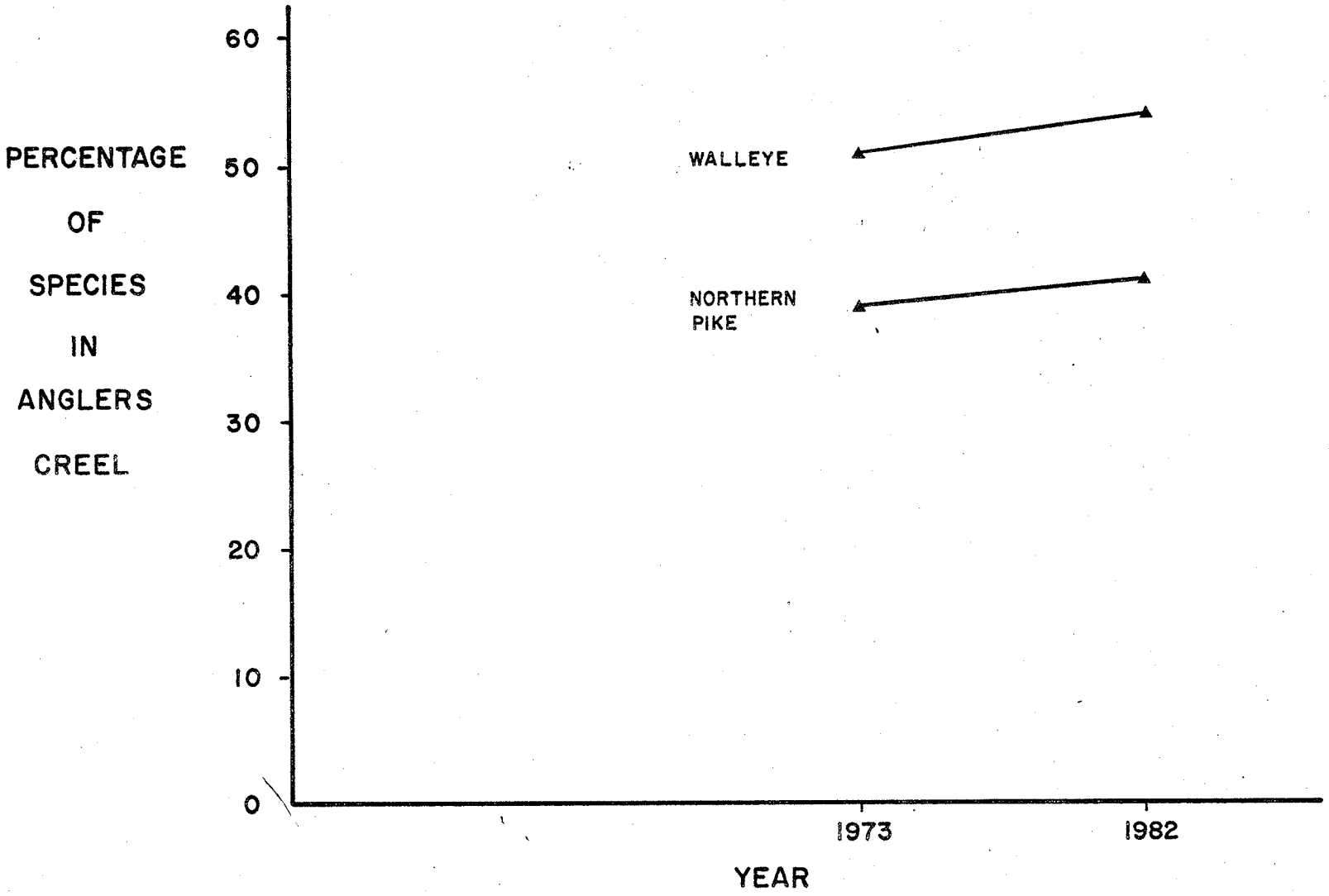


Figure 10 Percentage of Each Species in Angler Harvest from Past Angler Surveys on Big Whiteshell Lake.



On Brereton Lake, the percentage of walleye creeled by anglers increased dramatically since the previous survey done in 1973 (Figure 11). Percentage of northern pike, and yellow perch to a lesser extent, showed a corresponding decrease. Additional harvest of walleye accounted for the increased yield on Brereton Lake.

Changes in percentage of harvest over time on Nutimik Lake were erratic (Figure 12). An increase in harvest of walleye and sauger was evident since the previous survey done in 1974.

None of the increases or decreases in percentage of harvest by species were statistically significant ($P=0.05$, F test) for any species on any lake (too few data existed to perform the analyses for Big Whiteshell Lake). However, the harvest of lake sturgeon on Nutimik lake exhibited a steady decrease over time. The computed statistical F -value approached the statistically significant level. Although recent increases in walleye yield were evident on all four lakes, the number of years of survey data is small, and these increases were not consistent over time. Thus the increasing or decreasing trends over time were not statistically significant.

For all four lakes, the percentage of walleye in the anglers' creel was higher in the 1982-83 angler survey than in any past survey. This may have been a result of anglers becoming more selective: becoming 'better' anglers. The

Figure 11 Percentage of Each Species in Angler Harvest from Past Angler Surveys on Brereton Lake.

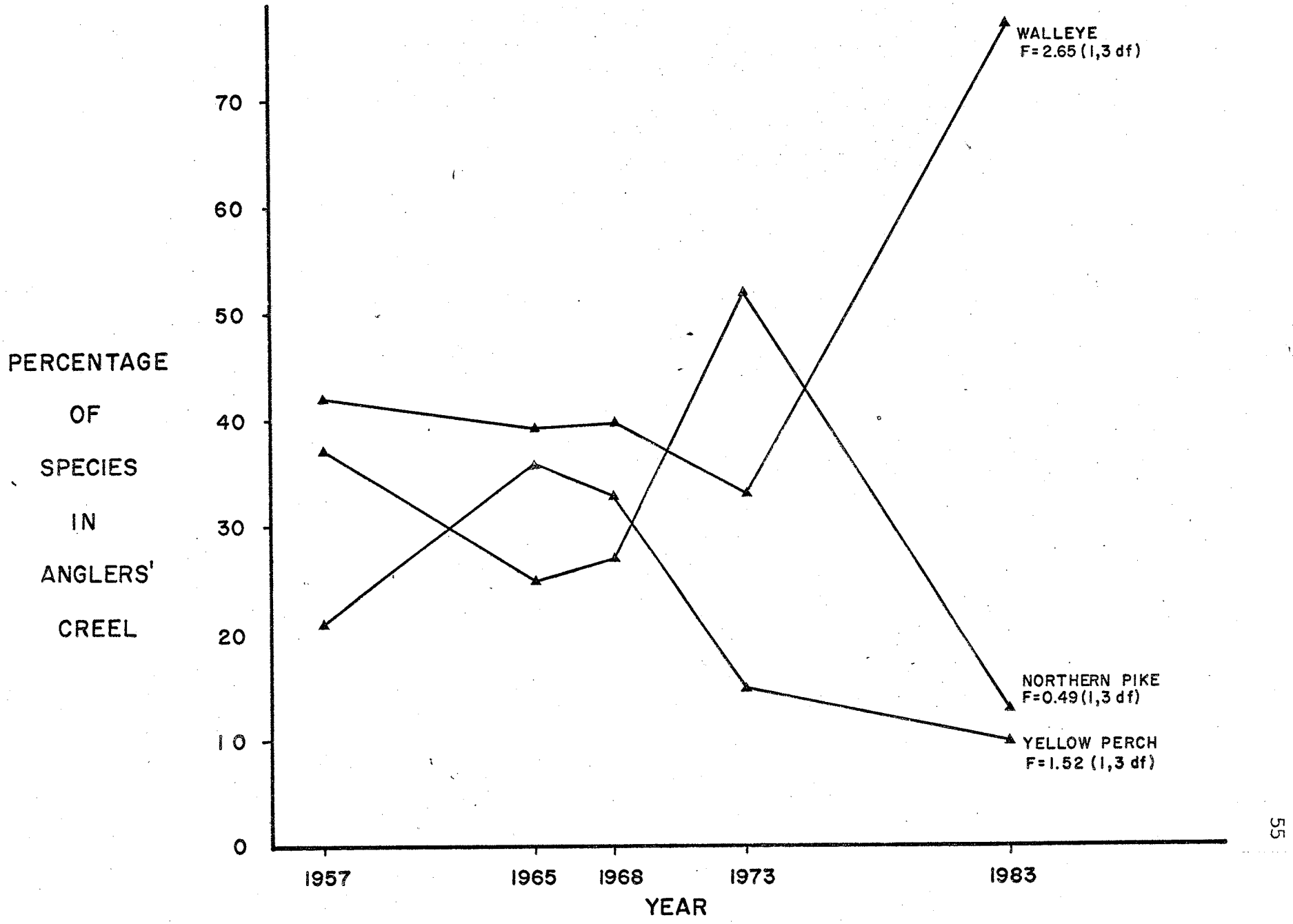
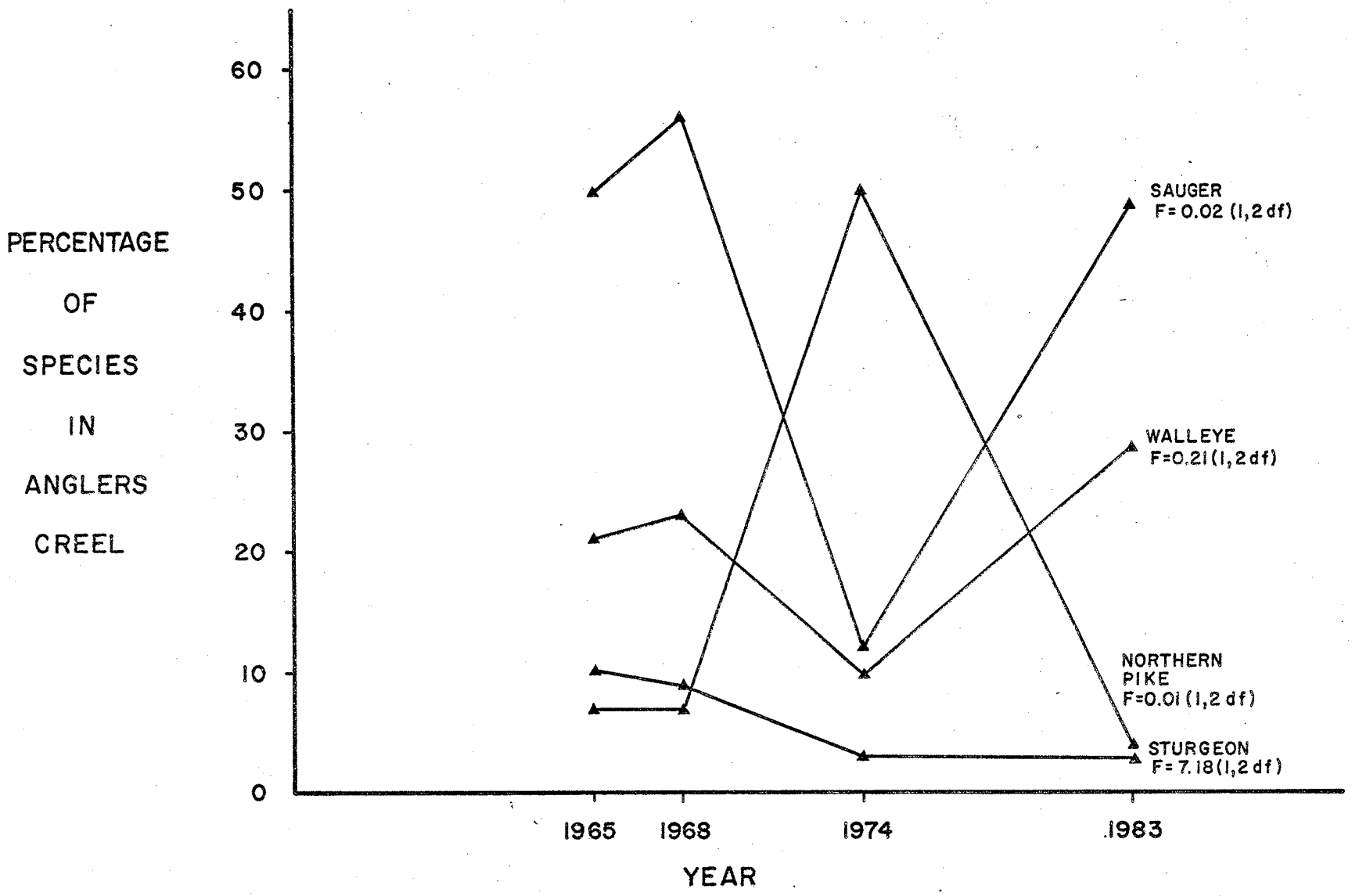


Figure 12 Percentage of Each Species in Angler Harvest from Past Angler Surveys on Nutimik Lake.



sophisticated angling equipment available on the market today may aid in creating this more selective angler who more often angles specifically for walleye. Alternatively, it is possible that angling, or other factors, may have caused changes in the species composition of the fish communities in the four lakes.

A small number of anglers harvested a substantial portion of the fish removed from the four lakes (Table 14). This phenomenon was especially true for walleye harvest. The percentage of walleye (sauger in the case of Nutimik Lake) harvested as part of a possession limit from the four lakes was a significant portion of the total harvest. The highest percentage was recorded for Brereton Lake. Additional large numbers of fish may have been harvested by anglers catching numbers only slightly below their possession limit.

The next chapter, Chapter IV, will summarize the findings reported in this chapter, and will discuss the significance of these findings for each of the four lakes.

TABLE 14

Estimated Numbers of Possession Limits, by Lake and by Species, Harvested from the Four Lakes Surveyed.

Lake, Species[1]	# Of Possession Limits Taken[2]	% of Total Number Harvested
Falcon		
Northern Pike [3]	11	23%
Walleye [4]	27	20%
Big Whiteshell		
Northern Pike	11	5%
Walleye	38	12%
Brereton		
Walleye	142	38%
Nutimik[5]		
Sauger [4]	55	25%

[1] Species not listed for a given lake indicates no possession limits were recorded during the survey.
[2] Data contained in this table are approximations. The creel census technique used did not record precise numbers of possession limits harvested.
[3] Possession limit during 1982-83 for northern pike was eight
[4] Possession limit during 1982-83 for walleye or sauger, or a combination of the two species, was eight.
[5] Data for lake sturgeon are not included (possession limit was one).

Chapter IV

SUMMARY, CONCLUSIONS

Summary of Survey Results

Following is a summary of the results contained in Chapter III.

1. Angling effort per unit area varied from a low of 5.6 angler-hours/ha on Falcon Lake, to a high of 21.9 on Nutimik Lake. Statistically, the differences between the four lakes were highly significant (P=0.01, F test).
2. Although some fluctuations occurred, angling effort remained relatively constant over time on Big Whiteshell, Falcon, and Nutimik Lakes. Angling effort increased over time on Brereton Lake, although this increase was not statistically significant (P=0.05, F test).
3. Relatively few non-resident anglers used the fisheries on the four lakes. The highest percentage (7.5% of anglers) was found on Big Whiteshell Lake.
4. Between 70% and 88% of anglers on all four lakes stayed at either cottages or campgrounds. Lodge users on Big Whiteshell Lake and day-users on

Brereton Lake were more numerous than on the other lakes.

5. The differences in catch per unit effort between lakes was statistically significant (P=0.05, F test). The rates varied from 0.27 fish/angler-hour on Falcon Lake to 0.42 fish/angler-hour on Brereton Lake.
6. No consistent trends in catch per unit effort were apparent over time. Some decrease was evident for Falcon Lake. Catch rates increased slightly since the last surveys in Brereton and Nutimik Lakes.
7. Non-resident anglers generally experienced a higher catch rate than residents, and they harvested more fish per angler-day than residents.
8. Anglers staying at cottages were more successful (0.37-0.49 fish caught/angler-hour) than those staying at campgrounds (0.18-0.37 fish caught/angler-hour). Anglers staying at lodges were also relatively successful (0.48-0.54 fish caught/angler-hour) on the two lakes, Big Whiteshell and Nutimik, where sufficient data were collected. Day-users on Big Whiteshell and Brereton, but not on Falcon and Nutimik Lakes enjoyed relatively high angling success rates
9. Amount of fish harvested by all anglers from a given accommodation type varied by lake. Campers on Big Whiteshell, day-users on Brereton, and cottagers on all lakes were more significant users of the fish resource.

10. Angling yield varied from a low of 0.93 $kg.ha^{-1}.yr^{-1}$ on Falcon Lake to a high of 4.00 $kg.ha^{-1}.yr^{-1}$ on Brereton Lake. Yield for Falcon Lake was substantially lower than for the other three lakes.
11. Angler harvest decreased over time on Falcon, Big Whiteshell, and Nutimik Lakes, and increased on Brereton Lake. None of the trends was statistically significant ($P=0.05$, $\underline{F}$ test), although the increase on Brereton Lake approached statistical significance.
12. Seasonal angling patterns varied from lake to lake. On Falcon and Nutimik Lakes, angling effort, yield, and catch per unit effort were higher for the period after 1 July, rather than before that date. On Big Whiteshell and Brereton Lakes the reverse was true.
13. Exploitation level varied from a low of 31% on Falcon Lake, to a high of 95% on Brereton and Nutimik Lakes. The consistently high values over time for Nutimik Lake may be due to the inapplicability of Ryder's criteria (1974) to this lake.
14. Percentage species composition of the angler's creel varied widely over time. For all four lakes, percentage of walleye in 1982-83 was higher than for any other year. A consistent decrease was evident for percentage of lake sturgeon in angler harvest on Nutimik Lake.

Conclusions

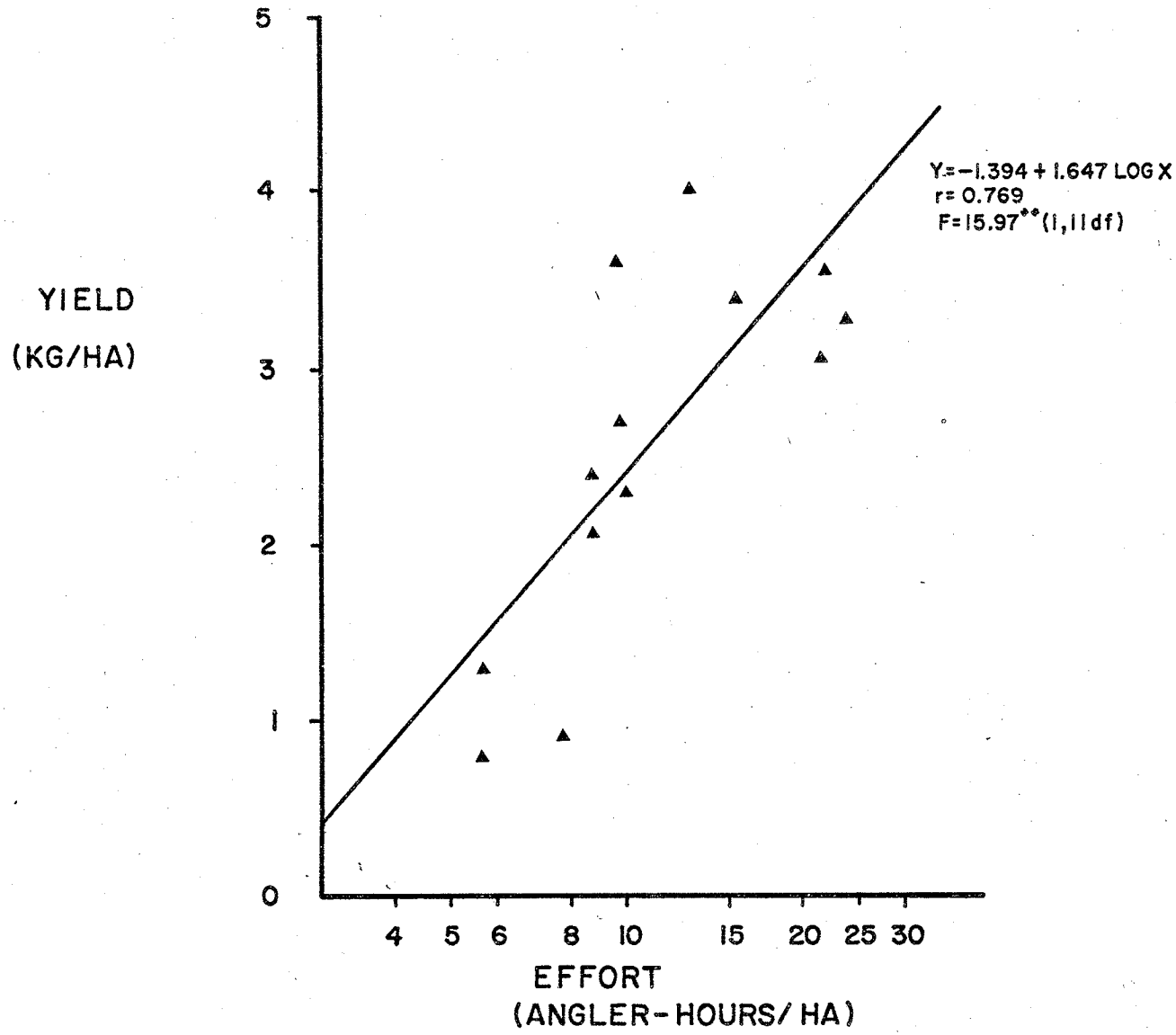
The fisheries on the four lakes surveyed as a part of this research project, Falcon, Big Whiteshell, Brereton and Nutimik Lakes have certain similarities. Cottagers and campers constitute a large majority of anglers using the fisheries. The proportions of each varied by lake, but the dominance by the two groups combined was consistent.

Few non-resident anglers use the fisheries. Only on Big Whiteshell Lake did more than four percent of the anglers have non-resident licenses. In part, Whiteshell Park attracts anglers and other recreation-seeking individuals from southern Manitoba because of its proximity to those individuals. They are also attracted because of the variety of recreational opportunities associated with the Precambrian Shield and boreal forest environment. Non-residents may also enjoy this environment, but the advantage of residing relatively nearby is lost. Trophy angling opportunities are for the most part not available in the intensive recreation zones. Non-resident anglers in Whiteshell who visit primarily for the purpose of angling are more likely to use less accessible fisheries in wilderness or back country zones. Over 50% of the angler-days expended in 1984 on three back country zone lakes (Crowduck, Echo, and George Lakes) were by non-residents (Fisheries Branch files, eastern region).

On a province-wide basis, a significant relationship has been demonstrated between yield and effort for a series of individual lakes. The correlation between these two parameters is highly significant (P=0.01, F test)for the set of data from past angler surveys on the four lakes included in this study (Figure 13). Angling effort can be used to predict yield, and along with MEI can be used to predict much of the variability in sport fishing yields (Schlesinger and McCombie 1983). Although the catch per unit effort between the four lakes was significantly different, no significant increasing or decreasing trends through time for catch rate were established.

Another similarity among the four lakes was the high percentage of walleye in the anglers' creel. The probable cause for this phenomenon is the average angler's increasing skills and more sophisticated equipment. More anglers have learned effective techniques for angling specifically for walleye. Anglers possess the knowledge and equipment to locate good walleye habitat and population concentrations. The two items of 'hi-tech' equipment most common to particularly successful anglers were depth-sounders and electric trolling motors. The depth-sounders enabled them to locate fish habitat and concentrations, and the motor allowed them to effectively maneuver in a small angling 'hot-spot' area. The number of commercial outlets promoting angling equipment for serious anglers has increased in

Figure 13 Relationship Between Yield and Angling Effort for Past Angler Surveys on the Four Lakes Surveyed.



recent years. These establishments, as well as numerous publications available to anglers, teach superior techniques for angling walleye and other species of fish.

Many anglers have increased their knowledge of walleye angling techniques. However, a minority possess 'hi-tech' angling gear. This minority may be able to angle a significant proportion of the total harvest. As much as 38% of walleye harvested from one lake during this survey was taken in the form of a possession limit. The highest value was recorded on Brereton Lake. The old fisheries maxim that 10% of the fishermen catch 90% of the fish may or may not be true, but a few anglers caught a sizeable percentage of the annual harvest.

This survey did not count the number of different individual anglers encountered on each lake. One angler fishing for two days was recorded as two angler-days. Some anglers fished repeatedly on the same lake. During one angling season they may account for a significant proportion of the annual harvest. For instance, this occurrence was observed on Nutimik Lake in 1983. One angler harvested many limits of sauger, and may individually have affected the fish resource.

The era of the skillful and well-equipped angler has arrived. Fisheries managers must recognize this. They must adjust management programs so as to provide adequate angling

opportunities to both the skillful and not so skillful angler, while maintaining the fish resource.

Falcon, Big Whiteshell, Brereton and Nutimik Lakes are defined as intensive recreation zone lakes. Fisheries managers may be tempted to manage the lakes in these zones as a relatively homogeneous group of waterbodies that have similar characteristics. Although this blanket management treatment may be valid, the results from this research project have accentuated the diversity, rather than the similarity of the four lakes. Results from each lake are discussed below:

Falcon Lake

Utilization of the Falcon Lake fishery was low compared to the other three lakes in this study. The angling effort per unit area, the catch per unit effort, the yield, and the exploitation rate were all lower than for the other three lakes. Although the catch rate was low, it did not appear to be decreasing further over time. However, the effort, and therefore the yield, decreased since the last survey. The yield in 1982 was lower than any value estimated from past surveys on the four lakes in this study. Only 31% of the estimated biological production potential was harvested by anglers. Spear fishing did not comprise a significant proportion of the harvest

Cottagers were the most numerous user group angling on Falcon Lake. The catch per unit effort they enjoyed, 0.37 fish per angler-hour, was more than twice that of other user groups, of whom campers were the most numerous. Anglers from cottages probably had better knowledge of the lake and the location of good 'fishing holes', than did other anglers, thus accounting for their higher catch rate.

The low effort expended, and the low catch rate experienced by anglers other than cottagers may be a reflection of the type of angler attracted to the Falcon Lake area. Many other outdoor recreational activities are available in or near Falcon Lake. The townsite within

Whiteshell Park contains such facilities as a golf course, a miniature golf area, tennis courts, etc. This complex attracts a diverse cross-section of people and campers, many of whom are not anglers, or are not serious anglers. Such individuals may for the most part not participate in angling, or may not be very successful should they do so.

The catch per unit effort in Falcon lake was markedly higher, 0.33 vs. 0.18 fish caught per angler-hour, for the period after 1 July vs. the period before 1 July. The knowledgeable anglers, whose catch rate would have been higher, may have preferred lakes other than Falcon Lake during the latter time period. Although angling improved at this time, heavy use of the lake's waters by other recreationalists such as water-skiers and pleasure boaters, particularly on weekends, may have deterred many anglers. Cottagers are less mobile and presumably continue to use a fishery under such circumstances.

Falcon lake is an anomaly. From the results obtained during the angler field survey, it is not clear whether the fish resource has deteriorated, whether the characteristics of the fish habitat are less favourable to anglers, or whether the angler clientele of the fishery is different from the other lakes surveyed.

Big Whiteshell Lake

The total effort expended by anglers on Big Whiteshell Lake was the highest of the four lakes surveyed. Despite this popularity in terms of absolute numbers of anglers, only on Falcon lake was the estimated effort per unit area lower. The catch per unit effort, at 0.41 fish caught per angler-hour, was relatively high among the four lakes, but the yield was about average. Catch per unit effort had not changed since the previous survey. The exploitation level was estimated to be 52%. Ice fishing is a popular activity on Big Whiteshell Lake, more so than on the other three lakes. Ice fishing harvest, not measured as a part of this survey, may have slightly increased the yield and therefore the exploitation level.

Campers were an important component of the numbers of anglers on Big Whiteshell Lake. They comprised a higher percentage of anglers than on any other lake. More non-resident license holders were present on Big Whiteshell Lake, although their numbers were relatively small (7.5% of anglers). Presumably due to the presence of three commercial lodges on the lake, the percentage of anglers from this type of accommodation was higher than for the other three lakes.

Big Whiteshell Lake was the only lake where northern pike comprised a significant percentage (41%) of the fish kept by

anglers. This percentage had remained relatively constant since the last survey. The other three lakes showed marked declines in northern pike harvest. Angling effort and especially angling harvest were concentrated in the time period before 1 July, rather than the time after that date. Anglers expended 56% of their effort to catch 74% of the fish, including 82% of the northern pike before 1 July. A common belief among anglers states that northern pike caught in cold water (i.e. before 1 July) tastes better and has firmer flesh than when caught later in the year. This may partially account for the relative popularity of northern pike angling in Big Whiteshell Lake.

Big Whiteshell Lake provided good fishing for a southern road-accessible lake, and shows no obvious signs of deterioration or over-fishing. It supported the heaviest use of the four lakes surveyed, but is the largest, and has the highest production potential.

Brereton Lake

The angling effort per unit area on Brereton Lake was high in 1983, and the three angler surveys since 1968 have demonstrated a consistent but slight increase in effort. The estimated catch per unit effort was relatively high for a Whiteshell intensive recreation zone lake. The catch rate increased since 1968. A very high value of 0.83 fish caught per angler-hour was estimated in 1957. This high value may have been due to relatively low effort expended on the fishery until that time, or may be an indication of high productive potential on Brereton Lake. The yield (4.00 $kg.ha^{-1}.yr^{-1}$) in 1983 was the highest of any of the four lakes, and was the highest value recorded during any survey done on the lakes in the past. The exploitation level, at 95%, was very high.

Cottagers were the largest group of users on the lake. Brereton was also used by a higher proportion of day-users than any other lake. These day-users were only the third most numerous group on the lake - after cottagers and campers. However, they angled for a longer period of time (3.9 hours/angler-day) than any other group on any of the four lakes, and thus harvested the biggest proportion of fish from Brereton Lake. An estimated 38% of the walleye angled on Brereton Lake was taken as part of a possession limit. The proportion of the harvest composed of walleye increased dramatically, compared to all four previous

surveys conducted on the lake. These characteristics of the Brereton Lake fishery all may be symptoms of change in harvest patterns due to the more knowledgeable angler with his sophisticated gear.

Many of the above results suggest that Brereton Lake was overharvested in 1983. It seems unlikely that the same level of harvest can be extended indefinitely into the future. Catch per unit effort will decline. Increased effort would then be necessary to attempt to maintain the harvest, or more likely, many anglers would travel elsewhere as the fishing quality declined.

The possibility does exist that high walleye harvests will continue into future years. The production potential, as computed according to Ryder (1965) often represents a conservative figure for sport fisheries. Walleye and other percid yields are often underestimated by this method (SPOF, 1982). It seems more likely, however, that Brereton Lake was overharvested in 1983.

Nutimik Lake

Effort per unit area on Nutimik Lake was the highest among the four lakes surveyed. The effort increased since the last survey in 1974, but was lower than estimates made in 1965 and 1968. The catch per unit effort remained about constant since the last survey, but rose above the very low levels experienced in the 1960's. The yield dropped slightly, but remained relatively high, and was second only to the high value estimated for Brereton Lake. Unlike Brereton Lake, the yield in Nutimik Lake had been consistently high in the past.

Lake sturgeon harvest has exhibited a steady decline over the time period covered by the four surveys. Angling success for this species was very low at 0.01 sturgeon caught per angler-hour. Anglers fishing specifically for sturgeon experienced a catch per unit effort of 0.025 sturgeon kept per angler-hour. These sturgeon anglers fished for 4.3 hours per angler-day, as compared to the average for all anglers of 2.8 hours per angler-day. The resulting sturgeon harvest, although small in numbers, comprised 26% by weight of the annual harvest.

Cottagers and campers contributed about equally to angling effort on the lake, although cottagers were slightly more successful, as was the case for all four lakes. Anglers staying at lodges enjoyed the highest catch per unit

effort of any group on any of the four lakes, but their numbers were relatively small.

The exploitation level on Nutimik Lake was estimated at 95%, the same value that was estimated for Brereton Lake. However, this level may be an overestimation of the actual exploitation level. The very high flushing rate, and to a lesser extent, the water level fluctuations present on the lake, transgress the criteria (Ryder 1974) that are suggested for relatively precise application of the MEI. Nutimik also supports a more diverse game fish community than the other three lakes. Six different species each constituted five percent or more of the annual harvest. Only two or three species were frequently harvested on Falcon, Big Whiteshell, or Brereton Lakes. The MEI formula may be more applicable to a more diversified fish community (SPOF 1982).

Nutimik Lake supported a high yield, and a high exploitation rate. This level has remained high, however, over a long period of time. In the case of Nutimik Lake, trend through time information may be of more consequence than the absolute value of the high exploitation level as calculated according to Ryder (1965).

Chapter V

MANAGEMENT STRATEGIES AND RECOMMENDATIONS

A WHITESHELL MANAGEMENT STRATEGY

The general goals and objectives of the Department of Natural Resources relating to the management of sport fishing in Whiteshell Park are outlined in Appendix 'C'. This appendix includes goals from Fisheries Branch, Parks Branch and the Department as a whole.

A large majority of anglers using the fisheries on the lakes surveyed were Canadian residents. The demand for angling by residents exceeds the supply. The present policy of allocating the fish resource in the intensive use zones primarily to resident sport anglers should be continued (Manitoba Department of Natural Resources 1983d). Economic benefit from non-resident angling should continue to be secondary. However, existing commercial operations catering in part to non-resident anglers should be considered in any management strategy or programs (Manitoba Department of Natural Resources 1983d).

The desirability of maintaining the viability of a fishery that will provide adequate angling opportunities and/or recreation is mentioned under the general goals and

objectives of virtually all agencies establishing such goals. This is documented in Appendix 'C' for the Manitoba Fisheries Branch and Parks Branch. The Ontario Ministry of Natural Resources also echoes this idea (Ontario Ministry of Natural Resources 1983; Ontario Ministry of Natural Resources 1982).

Catch per Unit Effort

Angling quality may not mean the same thing to all anglers. The surroundings, such as the boreal forest, Precambrian Shield environment of Whiteshell Provincial Park, may be important to some individuals. Others may place more value on the companionship of other anglers and/or their family. Some anglers may value the opportunity to catch a trophy fish, or to catch a number of smaller fish. Angling quality is a complicated concept that is difficult to define on a universal scale. However, all anglers by definition attempt to catch some fish, and therefore one component of angling quality is catch per unit effort.

Catch per unit effort provides a first order, readily measurable estimate of angling quality. This research project estimated catch rates between 0.54 and 1.05 fish caught per angler-day, and between 0.27 and 0.42 fish caught per angler-hour, for the four lakes surveyed. These values are typical of estimates made of catch per unit effort on southern road-accessible lakes in the past (Table 15).

With some exceptions, southern road-accessible lakes have provided a catch per unit effort in the range of 0.25 to 0.50 fish per angler-hour. Most of these results were estimated from Whiteshell intensive recreation zone lakes. Whiteshell Lakes with no road access provide better angling

TABLE 15

Catch per Unit Effort Recorded for Past Angler Surveys (Creel Censusses) Conducted in Manitoba.

Lake	Year	Fish Caught/ Angler-hour
Southern Road-Accessible Lakes:		
East Blue [1]	1978-82	0.10
Nutimik* [2]	1968	0.15
Nutimik* [3]	1965	0.20
Falcon* [4]	1968	0.22
Falcon*	1982	0.27
Gull [1]	1978-82	0.29
Brereton* [5]	1968	0.29
Brereton* [6]	1973	0.30
Nutimik* [6]	1974	0.32
Brereton* [3]	1965	0.33
Falcon* [3]	1965	0.33
Nutimik*	1983	0.35
Winnipeg R. below Pointe du Bois* [6]	1984	0.35
Two Mile [1]	1980-82	0.35
Falcon* [7]	1957	0.41
Big Whiteshell* [6]	1972	0.41
Big Whiteshell*	1982	0.41
Caddy* [3]	1965	0.41
Brereton*	1983	0.42
Eleanor* [3]	1965	0.44
Jessica* [3]	1965	0.49
White* [3]	1965	0.50
Jessica* [6]	1973	0.50
Lone Island* [6]	1972	0.52
Betula* [3]	1965	0.62
Jessica* [6]	1977	0.65
Brereton* [7]	1957	0.83
White* [6]	1977	1.13
Lone Island* [3]	1965	1.21
Southern Lakes -No Road Access:		
George« [6]	1984	0.58
Echo« [6]	1984	0.59
Caribou¬ [6]	1984	0.82
Crowduck« [6]	1984	0.87

Table 15 (continued)

Lake	Year	Fish Caught/ Angler-hour
Northern Lakes:		
Athapapuskow[8]	1975	0.5
Sassaginigak[6]	1980	0.90
Paint[9]	1968	0.9
Fishing[6]	1980	0.98
Reed[10]	1963	1.0
Paint[9]	1976	1.1
Paint[9]	1982	1.3
Setting[11]	1980	1.37
Gods[12]	1975	1.44
Harrop[6]	1981	2.27
Reed[13]	1979	2.36
Gods[12]	1974	2.43
Wrong[6]	1981	2.60
Goose[14]	1982	6.63

* Whiteshell intensive recreation zone lake.
« Whiteshell lake outside intensive recreation zones.
¬ Road access is poor
[1] Source: Valiant and Smith (1983).
[2] Source: Miller and Andrews (1972).
[3] Source: Andrews (1965).
[4] Source: Dennehy and Andrews (1969).
[5] Source: Sorochan and Andrews (1969).
[6] Source: Fisheries Branch files, eastern region.
[7] Source: Fedoruk (1957).
[8] Source: pers comm B. Bruederlin, Fisheries Technician, The Pas, Man.
[9] Source: Schlick [1985].
[10] Source: Schlick (1964).
[11] Source: pers comm G. McVittie, Fisheries Technician, Thompson, Man.
[12] Source: Hagenson and O'Connor (1978).
[13] Source: Bruederlin and Wright (1981).
[14] Source: Bruederlin (1982).

success rates in the range 0.50 to 0.90 fish per angler-hour. Lakes in northern Manitoba generally provide angling success rates above 0.90.

A statistically significant relationship between catch per unit effort and effort has been demonstrated on a provincial scale. The existence of such a relationship for Falcon, Big Whiteshell, Brereton, and Nutimik Lakes might aid in determining management strategies. No statistically significant relationship (P=0.05, F test) can be established from estimates from past angler surveys on the four lakes surveyed (Figure 14). The relationship between catch per unit effort and exploitation level was also statistically significant (P=0.05, F test) on a provincial scale. Such was not the case for the data collected from the four lakes surveyed (Figure 15). Apparently, catch rates have not been historically closely linked to either effort or exploitation level.

According to Andrews' (1968) evaluation scheme of fishing success based on catch per unit effort (Table 16), the fisheries on the four lakes should probably be rated as 'fair to good', in a continuum of 'poor', 'fair, 'good', and 'excellent'. Wang (1979) stated that over half of Whiteshell cottage owners thought that fishing was adequate on their particular lake. The percentage of cottage owners who considered the fishing to be adequate on the four lakes surveyed varied from 51% of respondents on Brereton Lake to 75% of respondents on Falcon lake.

Figure 14 Relationship Between Effort and Catch per Unit Effort for Past Angler Surveys on the Four Lakes Surveyed.

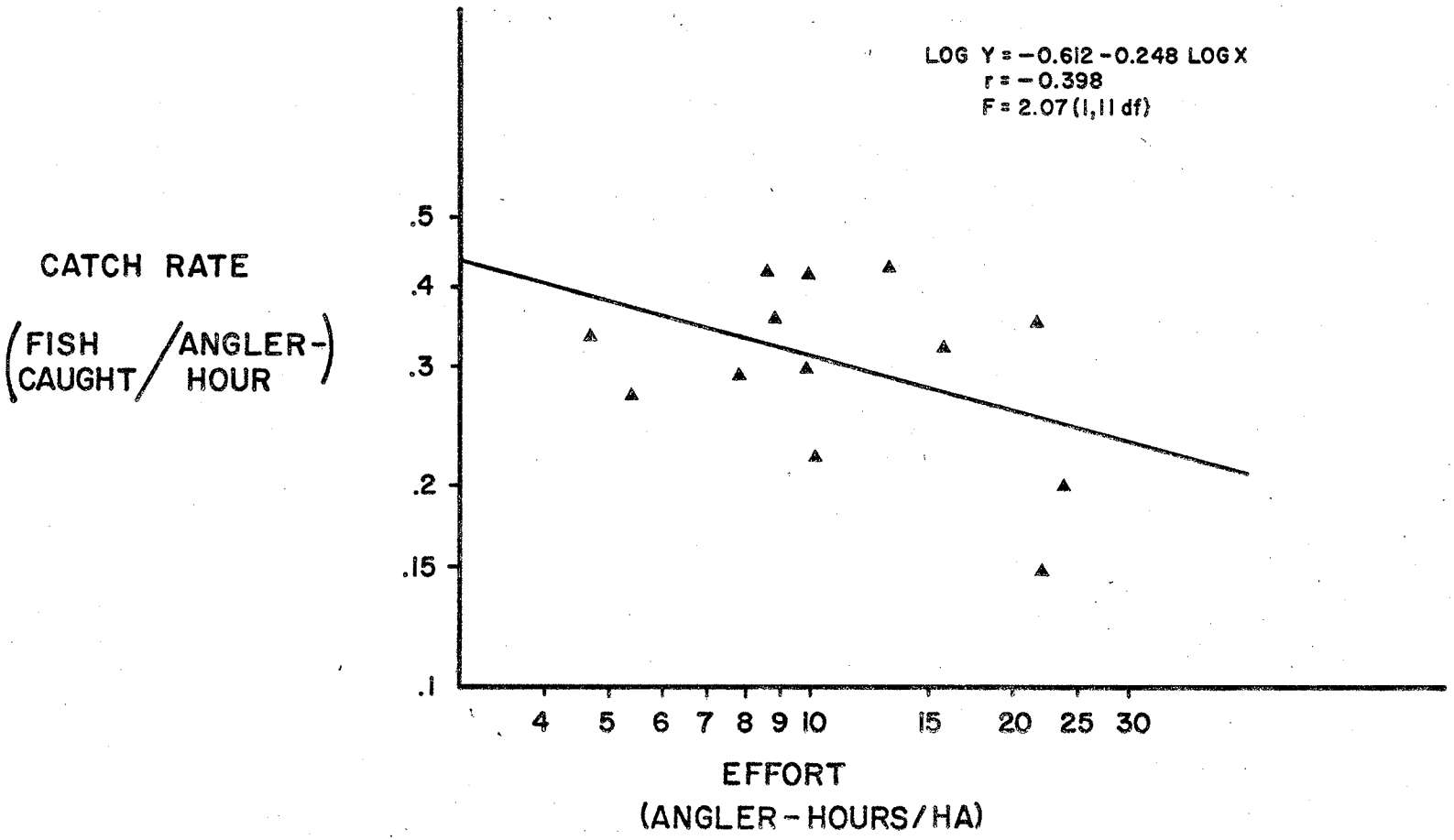


Figure 15 Relationship Between Catch per Unit Effort and Exploitation Level for Past Angler Surveys on the Four Lakes Surveyed.

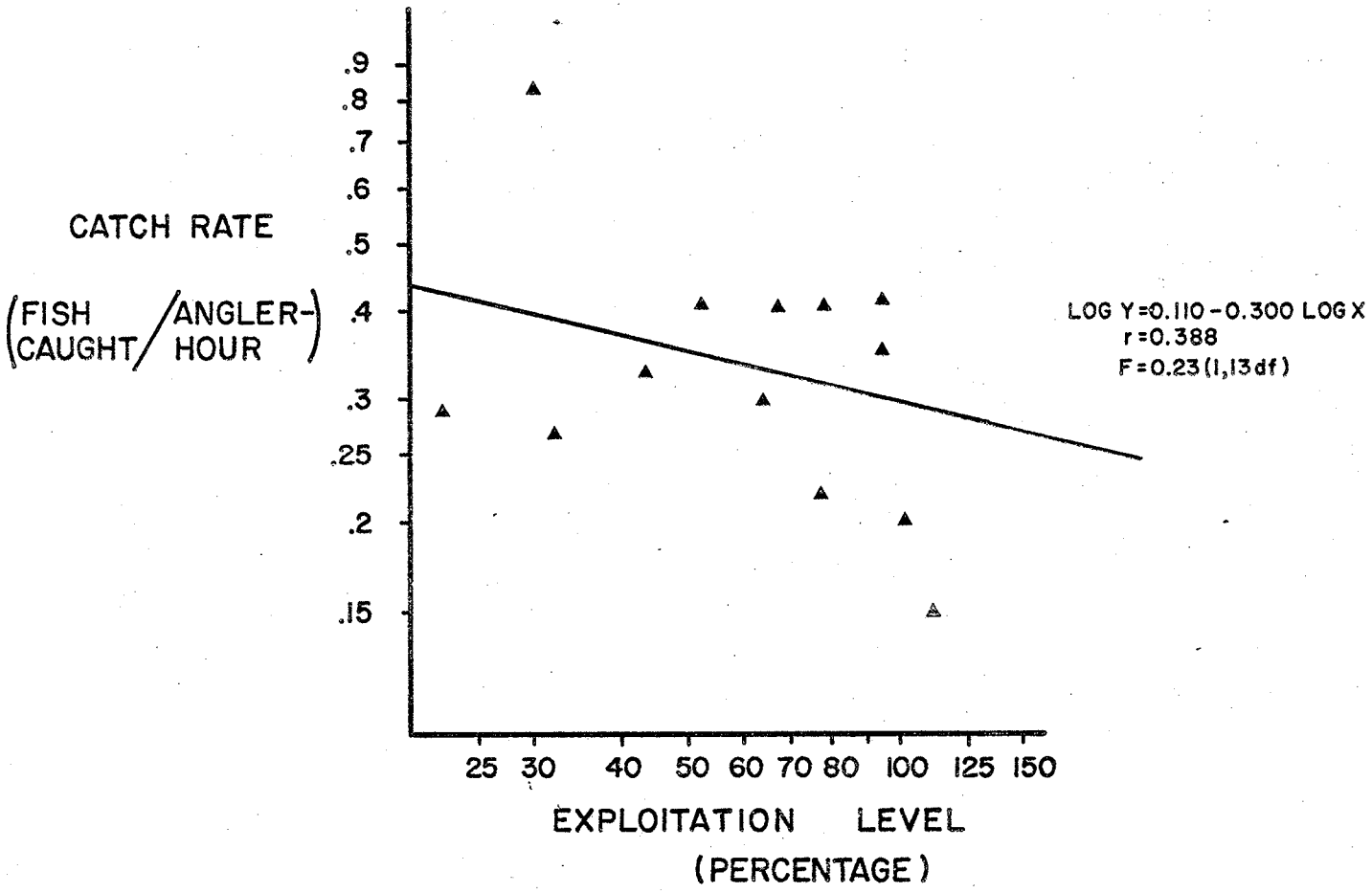


TABLE 16

Evaluation Scheme of Fishing Success Based on Catch per Unit Effort

Species	Poor	Fair	Good	Excellent
Northern pike	0.00-0.06	0.07-0.21	0.22-0.64	0.65-
Yellow Perch	0.00-0.01	0.02-0.04	0.05-0.13	0.14-
Walleye	0.00-0.09	0.10-0.24	0.24-0.55	0.56-

Source: Andrews (1968)

Valiant and Smith (1983) suggested 0.3 fish per angler-hour was a reasonable target for management of road accessible trout waters in the Duck Mountains. Mattson (1984) mentioned a figure of 0.25 - 0.30 fish per angler-hour as a minimum angling quality to be achieved on Whiteshell intensive recreation zone lakes. An objective of 0.25 to 0.50 fish caught per angler-hour is consistent with departmental goals, and is a realizable objective for Falcon, Big Whiteshell, Brereton, and Nutimik Lakes. The achievement of this objective will provide a base level of angling. A catch rate lower than 0.25 could result in anglers losing interest.

Provision of trophy angling opportunities in Whiteshell intensive recreation zone lakes is probably not a realizable objective. Very few master angler awards were recorded for the four lakes surveyed (Table 17). Such high quality

angling would be a more realizable objective on lakes where exploitation levels are lower. Lake sturgeon on Nutimik Lake represent a possible exception. Twelve percent of the estimated harvest was reported as master angler awards.

TABLE 17

Master Angler Awards Reported on Years When Angler Surveys Were Conducted for the Four Lakes Surveyed.

Lake[1] Species	Minimum Eligible Weight (kg)	# Reported (total)	# Reported by Non-Residents
Falcon (1982)			
Walleye	3.6	6	0
Northern Pike	9.0	3	0
Bass[2]	1.6	5	1
Lake Whitefish	1.8	1	0
Big Whiteshell (1982)			
Walleye	3.6	1	0
Northern Pike	9.0	6	0
Yellow Perch	0.6	4	1
Nutimik (1983)			
Walleye	3.6	2	0
Northern Pike	9.0	3	1
Mooneye	0.6	2	0
Lake Whitefish	1.8	1	0
Lake Sturgeon	11.0	11	0

[1] No master angler awards were recorded for Brereton Lake in 1983.
[2] Smallmouth bass

Sources: Manitoba Department of Business Development and Tourism (1984)
Manitoba Department of Economic Development and Tourism (1983).

Non-Consumptive Angling

Fisheries management in Whiteshell Park intensive recreation zone lakes must address the problem of distributing the benefit of a limited resource among a large, and possibly an increasing number of users. Fish stocks must be enhanced where possible, or at least maintained at current levels. Effort may be controlled by a variety of regulatory measures. When all possible strategies to meet these ends have been implemented, the fisheries manager has but one remaining management tool: to encourage less consumptive use of the fish resource. Anglers' attitudes about angling quality, and about what constitutes an acceptable sport fishing experience must change.

Falcon, Big Whiteshell, Brereton, and Nutimik Lakes cannot provide a possession limit of walleye to all anglers using these fisheries. The ability of these lakes to produce fish is finite, and is small compared to the large numbers of anglers annually using the resource. 'Catch-and-release' fishing must be encouraged. Repeat use of individual fish will allow increased use of the resource, and will increase overall angling quality. Fish mortality associated with catch-and-release techniques may vary depending on the type of gear used by anglers, and depending on the skills of anglers in releasing fish (Wydoski 1979). Caverhill (1979) stated that mortality from catch-and-

release angling was not a problem, particularly if gear restrictions such as barbless hooks and artificial lures were also used.

Catch-and-release fishing was practised to some degree on the four lakes surveyed. However, the percentage of walleye released was relatively low (Table 18). The 23% of walleye released on Nutimik Lake was higher than on the other lakes. This phenomenon may have been due to the smaller average size of walleye on Nutimik Lake. Anglers frequently confused walleye and sauger. Some of the released 'walleye' may have been sauger. Release of some other species, such as northern pike, was more common. Smallmouth bass was kept in the anglers' creel even less often. They were released more than half the time.

The existing supply-demand imbalance for accessible southern Manitoban fisheries should be addressed by fisheries managers. Catch-and-release fishing, along with appropriate changes in angling gear, such as barbless hooks, should be vigorously promoted to anglers in Whiteshell Park. If angling opportunities are to be made available to all anglers, not just those with 'hi-tech' equipment, then anglers' attitudes must change. The value of the 'sport' in sport-fishing, and the value of an outdoor experience in a Precambrian shield park setting should be emphasized.

TABLE 18

Percentage of Fish Released by Anglers on the Four Lakes Surveyed. (No. of Fish Released on Days Censussed Enclosed in Parentheses)

Species	Falcon	Big Whiteshell	Brereton	Nutimik
Walleye	10% (22)	8% (44)	9% (50)	23% (49)
Northern pike	39% (38)	35% (290)	33% (48)	62% (51)
Smallmouth bass	53% (34)	-	-	56% (24)
Mooneye	-	-	-	0%[1] (0)
Sauger	-	-	-	23% (95)
Lake Sturgeon	-	-	-	13% (3)
Other species	55% (22)	51% (44)	52% (83)	56% (26)
Total	27% (116)	24% (378)	20%(181)	27%(235)

- indicates species not present.
[1] 0 of 60 mooneye were released.

RECOMMENDED FUTURE PROGRAMS

1. Monitor both the fish populations and the angler use of those populations in intensive recreation zone lakes. This study has raised questions about the fisheries of Falcon and Brereton Lakes, and about the impact of 'hi-tech' angling. A study of the fish populations, as well as repeating the angler surveys on these two lakes in 1985, is necessary. These programs, when implemented, will ascertain whether Brereton Lake is being overharvested, and what impact this overharvesting might have on the angling quality available. The programs will also aid in determining the status of the sport fishery on Falcon Lake: whether the low exploitation level may be attributed to a lack of interest by anglers, to a decline in fish stocks, or to other factors.

The fish population studies can be accomplished by present Fisheries Branch staff. The angler surveys will entail the employment of a creel census clerk for eighteen weeks. Support costs will be approximately $2000. If the clerk cannot be obtained through a student or other temporary employment program, an additional $4000. will be required.

2. This study has demonstrated the diversity of the lakes in the Whiteshell intensive recreation zones. The characteristics of sport fisheries on the other intensive recreation zone lakes are not well known. A program of surveying and evaluating these fisheries should be

implemented. Studying two lakes per year would permit coverage of all intensive recreation zone lakes in a seven year period. The costs per season for coverage of two lakes are the same as those listed above for Falcon and Brereton Lakes.

3. For future angler field surveys that are conducted on intensive recreation zone lakes, the following procedures are recommended:

a) Use the roving creel census technique. Despite the potential disadvantages of missed data and bias, it is the only practical method available for intensive recreation zone Whiteshell Lakes. Contacting anglers in the field by any other means would be very difficult and/or expensive. A substantial data base now exists from past angler surveys using the roving creel census technique. A change in method would confuse comparisons over time.

b) Interview shore anglers. Data from this source should be tallied independently of data from boat anglers. This separation will facilitate the comparison with past information from boat anglers.

c) Quantify angling activity and harvest information from off-season angling. The involvement of Regional Services Branch and other departmental staff outside Fisheries Branch may be necessary to accomplish this task.

d) Obtain weights, rather than lengths, of fish in the anglers' creel whenever possible.

e) Make hourly boat counts during the time period sampled by a creel census.

f) Collect information from anglers concerning the type of equipment used (i.e. the use of electric motors, depth sounders, or other 'hi-tech' equipment).

4. Determine the status of the lake sturgeon population in Nutimik Lake and connecting waterbodies. Sturgeon catch per unit effort has declined steadily over the time period covered by the angler surveys. Anglers, commercial lodge operators, and some departmental staff have complained of the small size of the average sturgeon angled. These groups have lobbied for a minimum size limit for this species. Poaching of sturgeon does occur, and has occurred for many years on Nutimik Lake and connected waterbodies. The amount of poaching occurring, and its effects on sturgeon stocks is not known. The status of the sturgeon resource should be evaluated to determine what, if any, changes in regulatory and/or enforcement programs are necessary. This program has been initiated by regional Fisheries Branch staff, and should be continued until sufficient data are collected to ensure effective sturgeon management.

5. Investigate areas in the four lakes surveyed where habitat improvement is possible. The research contained in this report has dealt only indirectly with the effects of

habitat degradation. A study to identify possibilities for maintaining, rehabilitating, or enhancing fish habitat, when implemented, may have long term beneficial effects on sport fisheries. Provision of fish passage on spawning streams, and rehabilitation or creation of spawning beds are examples of possible recommendations from such a study. This program has been initiated in 1984. Funding necessary for the implementation of recommendations may be available from such sources as the 'Habitat Heritage Trust Fund'.

6. Determine the optimum management strategy for water level manipulation on the four lakes surveyed, and on other intensive recreation zone lakes. Water level manipulation is mentioned by Ryder (1974) as potentially affecting MEI, and consequently lake production levels. Artificial manipulation is practised to varying extents on all four of the lakes surveyed. The impact on fish populations, and on spawning and nursery areas is not known. Management beneficial or less detrimental to fish populations may be possible. An inter-disciplinary study, considering wildlife, recreation, and perhaps other concerns, as well as impact on fish populations, is necessary. Such a project might be suitable as a practicum topic through the Natural Resources Institute, University of Manitoba. $10,000 is necessary to fund such a project.

7. Investigate the possibility of effectiveness of stocking programs. Large scale stocking of walleye eyed-eggs or fry

may be expensive and/or ineffective. Some opportunities may exist for walleye rearing. The Alf Hole goose pond, and other areas on the Rennie River system upstream from Brereton Lake, for example, may be useful for this purpose.

8. Promote the use of currently less popular game fish species. This research project showed that anglers are increasingly harvesting walleye, rather than other species. The desirability of northern pike and yellow perch should be emphasized. These species are available in all intensive recreation zone lakes. Other game species available in Falcon and Nutimik Lakes should also be advertised. Species presently considered as non-game species, but abundant in the four lakes surveyed should also be promoted. Lake whitefish (Coregonus clupeaformis) and/or tullibee (Coregonus artedii) are abundant in all four lakes (Fisheries Branch files, eastern region). These species of fish are generally considered desirable when caught by anglers. A creel census clerk working on Crowduck Lake in Whiteshell in 1984 reported that skilled anglers were consistently able to catch tullibee.

9. Promote 'catch-and-release' and other less consumptive angling techniques. As discussed earlier in this chapter, adoption of such techniques is necessary if a limited resource is to supply an acceptable angling experience to an increasing number of anglers. A systematic and consistent approach to disseminating such ideas is necessary. Barbless

hooks, other types of gear that reduce fish mortality, and appropriate handling methods should be publicized.

10. Aim public relations campaigns designed to inform anglers at campgrounds and cottages. Between 70% and 88% of anglers on the four lakes surveyed were campground or cottage dwellers. These anglers may be contacted through such media as cottagers and campers associations, and their associated publications. Visitor services programs, presently in operation by Parks Branch also should be used to contact anglers from cottages and campgrounds. Other departmental programs that contact angling clubs, etc, may be necessary to reach day-use 'hi-tech' anglers. The above programs can be incorporated into existing programs of Fisheries Branch and Parks Branch.

11. Investigate the effects of 'hi-tech' angling equipment, fish derbies, and fish tagging for prizes. This information can be collected through appropriately designed angler field surveys, as recommended earlier in this chapter. The use of the fisheries resource by sophisticated anglers, or by concentrations of anglers, may adversely affect the resource, as suggested earlier in this chapter.

12. Plan for the reduction of possession limits.* Walleye limits must inevitably be reduced if an acceptable angling quality is to be maintained. Possession limit reductions

* The possession limit for smallmouth bass was reduced from 8 to 4 in 1984.

for other species may also be necessary. User groups, such as commercial lodge operators, who may be adversely affected, should be consulted. The options available, and the probable consequences of each should be presented. Reductions of possession limits for walleye alone may succeed in transferring some angling pressure to less exploited species such as northern pike.

13. Review all plans for expansion of development on or near the intensive recreation zone lakes. Any increase in accommodation or other facilities, may attract more anglers, and may impact the fish resource. Any proposed expansion of commercial lodges, campground sites, numbers of cottages, etc., should be evaluated in terms of probable impact upon the fishery. This impact should be considered in analyzing the potential social benefits and costs of a given proposal. This procedure may be undertaken as a part of normal departmental review processes.

14. Co-ordinate the above programs. For example, regulation changes and education programs should be complementary in promoting less consumptive angling patterns, and in providing suitable angling opportunities.

SUMMARY OF RECOMMENDATIONS

1. Conduct angler field surveys on Brereton and Falcon Lakes in 1985. Monitor the status of fish populations on these lakes.
2. Conduct angler field surveys on other intensive recreation zone lakes as part of an on-going program.
3. Implement procedures as outlined above when designing angler field surveys on intensive recreation zone lakes.
4. Determine the status of lake sturgeon stocks in Nutimik Lake and connecting waters.
5. Continue to investigate, and implement, fish habitat improvement and habitat maintenance programs.
6. Determine the impact of water level manipulation on fisheries in the intensive recreation zones.
7. Investigate the possibility and effectiveness of walleye rearing and/or stocking programs.
8. Promote angler use of 'non-game' fish species, and species other than walleye.
9. Promote 'catch-and-release' and other less consumptive angling techniques.
10. Direct education and information campaigns in intensive recreation zones at cottagers and campers.
11. Investigate the impact on intensive recreation zone fisheries of 'high-tech' angling, derbies, and tagging for the purpose of awarding prizes.

12. Plan to reduce limits for walleye, and possibly other species.
13. Evaluate the effect on the fisheries of all proposed infrastructure and accommodation expansions.
14. Co-ordinate the above programs to achieve maximum effectiveness.

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APPENDICES

Appendix A

REVIEW OF CREEL CENSUS TECHNIQUES

A creel census refers to a census conducted by an enumerator, who through direct observations of the fishing process, as through interviews conducted with anglers, records information permitting the determination of the kind and numbers of fish taken, and the rates at which they are caught (Robson 1961). The main purposes of a creel census are to estimate: fishing pressure or effort; rate of success or catch per unit effort; harvest or yield in numbers and/or weight; and to assess the value of fishery management techniques (Olver 1970). The results of some creel censusses are used only to provide an index of fishing pressure, by comparisons with past censusses (Hawkinson and Krosch 1972).

In the roving creel census technique, the enumerator roves through the fishing area, interviewing fishermen as he encounters them, to determine number of fish caught, and the time expended (Robson 1961). It is intuitively clear that the roving creel census with its moving enumerator is more efficient; what is not intuitively clear is how to utilize the data thus collected (Robson 1960). The roving creel census has several distinctive features: the open end of

the sample size (the number of interviews to be conducted is not predetermined); the sample is systematic (anglers are interviewed as they are encountered along the route); the probability of interviewing any one angler depends on the length of time he spends fishing; and incomplete information is collected from any one fisherman (Robson 1961).

Complete censusses of a given lake are very costly and are usually impractical for this reason (Hawkinson and Krosch 1972). The alternative is doing partial censusses over a larger area (Regier 1966a). Sample censusses, where a census, is conducted on a sample of time periods of the total time being studied, are generally used (Robson 1960). Random selection is needed in the sampling design in order to achieve unbiassed results.

A stratified random sampling design may be used to remove variability in the data which is due to the predictable differences between catch and effort expenditures between the strata. This stratification may be between weekends and weekdays, or between months, or a combination of the two (Valiant and Smith 1979). If the stratification scheme is taken too far, the variance within strata may become too large, may more than compensate for any benefit, and precision will be lost (Regier 1966a). If fishing pressure is light, any sampling involving less than 25% of the fishing days may not yield adequate data (Best and Boles 1956).

The total fishing effort can be computed from taking instantaneous counts of boats actively angling. This usally requires an additional worker, other than the enumerator(s), to perform this function (Robson 1960). This count then represents the numbers fishing for the time period between counts, often one hour (Hawkinson and Krosch 1972). The complete census is only possible when the number of access points is limited (Carlander and DiCostanzo 1958).

An alternative, the roving creel census, is conducted by an enumerator starting his trip at a random point along a well-defined route that covers the angling area. He should choose a random direction along that pre-set route, and travel at a constant rate of a given number of circuits per day (Robson 1961).

Several problems are inherent in conducting creel censusses and roving creel censusses. They are unique in statistical analysis, and are not simple matters to design. No completely satisfactory design has been discovered for the roving creel census (Regier 1966b). Some of the potential problems that may arise are: poor questioning techniques by the enumerator; poor questionnaire design; a non-random selection of participants; and improper survey design (Sinclair and Morley 1963).

The catch per unit effort is dependent on the angler's knowledge of his time fishing. A study done in Minnesota

concluded that the actual time fishing was closely approximated by the anglers' estimates of that time (Carlander and DiCostanzo 1958). In a roving creel census, only information on incomplete trips is obtained, and the major weakness is the unknown bias of estimation of total catch. The nature of the fishing process is not completely known: the angler's rules of stopping may be a function of the waiting time between catching fish. Catch rate at the time an interview is made is assumed to be an unbiassed estimate of catch rate for the complete trip (Robson 1961). Robson (1961) goes on to state that the only way to avoid this problem is to not use the roving technique, but to interview at access points. This, too, may not be without its problems since the anglers present at major access points may not be representative of all anglers on the lake (Carlander and DiCostanzo 1958). Malvestuto et al (1978) concluded that catch per unit effort estimated by a roving creel census was an unbiassed estimate.

Each creel census design must be tailored to a particular application. The idealized sampling plan, as described by Robson (1961), is not attainable in practice.

Appendix B

REVIEW OF THE MORPHOEDAPHIC INDEX

The morphoedaphic index (MEI) is an empirically derived formula. It provides a convenient method of rapidly calculating potential fish yield for unexploited north-temperate lakes (Ryder 1965). These restrictions have been somewhat relaxed: the MEI is now applied to moderately to heavily exploited lakes, as well as to various other climatic regimes (Henderson et al. 1973).

The formula for calculating the MEI is:

$$MEI = \frac{\text{Total Dissolved Solids (TDS) (in mg/l)}}{\text{Depth (in m)}}$$ (Ryder 1965)

The MEI essentially serves as an index at the ecosystem level of organization (Ryder et al. 1974). It is stable, and changes only with significant environmental changes. Given constant fishing intensity, the fish production will remain proportional to the MEI (Ryder 1965). Hanson and Leggett (1982) reported a value of about 2.0 separated eutrophic from oligotrophic lakes. Lakes with an MEI of about 2.0 could be classified mesotrophic. Sport fish crops apparently peak when the MEI is in the 20-50 range (Jenkins 1982).

Fish production or potential yield in a lentic environment is affected by three main abiotic influences: morphometric, edaphic, and climatic. Applying the MEI to lakes of a given region, originally north-temperate lakes, in effect holds climatic influences constant. The simple regression of the MEI (morphometric and edaphic factors combined) was found to be equally as effective as multiple regression on the two factors (Ryder 1965). The MEI is less effective in a lotic environment, where primary production is dependent more upon allochthonous material or sessile algae forms: hence the inapplicability of the MEI to waterbodies with a high flushing rate (Ryder et al. 1974).

The MEI provides a first order estimate of production potential. In the early development of a fishery, timeliness is often more important than precision: thus the importance of the MEI (Henderson et al. 1973). Evidence from African inland fisheries suggests that potential yield is not sensitive to stock composition. However, these fisheries support diverse fish communities (Henderson et al. 1973). This lack of sensitivity was also supported by findings in Lake Superior (Ryder 1965).

The MEI may be less appropriate for estimating angling yields than for estimating a commercial catch. It often represents a conservative figure for sport fisheries. Anglers may catch younger fish, and leave the older, larger individuals of a population to reproduce. The best

efficiency occurs when intermediate size fish are harvested. Walleye yields are often underestimated since percid populations may concentrate in shallow bays where recycling of energy and nutrients can become very efficient (SPOF 1982).

"While the inherent significance of total dissolved solids and mean depth is imprecise or even vague, it is of paramount importance to recognize that neither one of these apparently simple measures is representative of only one environmental variable, but rather depicts a whole complex of interrelationships in the ecosystem" (Ryder et al. 1974). The actual significance of TDS and mean depth within the MEI framework is not exactly known. However, TDS is usually proportional to one of its component ions such as phosphorous, nitrogen or carbon, that in themselves limit or indicate biological production (Henderson et al. 1973). TDS may be a better indicator than any of its component ions, which may be subject to more variation (Ryder et al. 1974). TDS in the MEI context serves to represent the edaphic conditions of the waterbody (Henderson et al. 1973), and is a surrogate for essential nutrients, supplied by edaphic processes (Oglesby 1982).

The mean depth value is probably the most important morphometric variable in a lake, and correlates inversely with the amount of euphotic/littoral zone (Ryder et al. 1974). Mean depth also represents shore development and

number of islands present, as well as being a function of volume or area (Henderson et al. 1973). It represents the way in which a lake processes energy and material (Oglesby 1982).

Simplicity has led to both praise and criticism of the MEI (Ryder 1982). The relative ease of measurement of mean depth and TDS allows rapid estimation for lakes where other data are not available. The 95% confidence interval for the MEI has been estimated to be between one-third and three times the MEI value. This results in a nine fold difference between minimum and maximum values of such an interval (SPOF 1982). Ryder (1982) states, however, that if moderate precision is not achieved, the criteria for application of the MEI have probably not been adequately met.

Some of the criteria for use are: a minimum size of 260 ha is suggested and the lake in question should be located in the north-temperate climatic region at an altitude of less than 600 m. The lake should not be subject to: significant pollution, a high flushing rate, very high inorganic turbidity, excessive water level fluctuations, or extensive winter or summer kill (Ryder et al. 1974).

Other alternatives to use of the MEI have been investigated. Use of chlorophyll a concentrations, macrobenthos biomass, and total phosphorous concentration have been substituted for TDS. These have been found

superior in predicting potential yield in some cases (Hanson and Leggett 1982). They also state that the MEI is an acceptable method if properly constrained: if its criteria for use are correctly applied. TDS is the most frequently used indicator (Jenkins 1982).

Appendix C

REVIEW OF GOALS AND OBJECTIVES OF THE DEPARTMENT OF NATURAL RESOURCES

This appendix contains the goals and objectives of the Department of Natural Resources and of Fisheries Branch and Parks Branch that are relevant to the management of fisheries in the intensive recreation zones of Whiteshell Provincial Park.

Department of Natural Resources

An overview of the Department's objectives include the following:

"The Department attempts to maximize the long-term economic and social benefits of natural resources to Manitobans through an integrated resource management approach which focusses on the following four distinct program areas:

1. Outdoor Recreation

   The Department is responsible for ensuring that Manitobans, wherever they live are provided with a diversity of outdoor recreational opportunities consistent with conservation principles and the resources available and which consider the enduring needs of society.

2. Economic Development

> Through protection, enhancement, conservation, and management of the natural resource base, the Department is responsible for ensuring that existing resource harvesting operations can be sustained and that new development initiatives can be pursued. The Department's programs also recognize the importance of resource harvesting and water management to the economic development and prosperity of local areas within the Province." (Manitoba Department of Natural Resources 1983c)

Other program areas of lesser importance in this application are "Subsistence" and "Public safety and protection of property."

Fisheries Branch

Allocation of the fish resource is priorized as follows:

- "Treaty Indian fishing."
- "Resident angling."
- "Commercial uses, such as commercial fishing, commercial sport angling, bait fishing and fish farming."
- "Non-Treaty domestic fishing" (Manitoba Department of Natural Resources 1983d).

The major objective of Fisheries Branch is to practise fisheries management "that will result in the greatest long term benefit to Manitobans and ensure survival and improvement of fish stocks" (Manitoba Department of Natural Resources 1983d). An additional objective to enhance the above is "to maintain and enhance angling opportunities for Manitobans to meet existing and future demands" (Manitoba Department of Natural Resources 1983d). Other objectives deal with commercial and domestic fishing, and are of lesser importance to this study.

Sport fisheries management objectives for the southern regions of the province are:

1. "To maintain a base level of angling opportunities for residents."
2. "To provide some opportunities for higher quality angling."
3. "To maintain and improve the viability of existing commercial sport fishing operations."
4. "To offset resource losses due to habitat loss and degradation through enhancement programs."
5. "To maintain the level of sport fisheries resource harvest at or near present levels." (Manitoba 1984a).

The existing (1980) level of angling opportunities should be preserved in the southern region. Less consumptive angling should be promoted through regulations and through public

education programs (Manitoba Department of Natural Resources 1984b).

High priority goals relevant to management of the intensive recreation zones fishery include: 1) "to minimize the loss and degradation of habitat due to other competing and non-competing resource uses and to improve degraded habitat," 2) "to meet the present and future demand for sport fish in Manitoba, the Fisheries Branch will protect, maintain and enhance angling opportunities," and 3) "to prevent the introduction of undesirable fish species and other aquatic fauna to Manitoba waters." (Manitoba Department of Natural Resources 1983d).

One medium priority goal may by relevant: "to derive significant levels of economic benefit for Manitobans from non-resident angling:, and one low priority goal: "to protect future options with respect to exceptional native fish species such as brook trout and lake sturgeon." (Manitoba Department of Natural Resources 1983d).

Parks Branch

At the time this paper is written, Parks Branch has no overall strategy for fisheries management in Parks. However, the following statements concerning outdoor recreation are relevant: Parks Branch wishes to provide a diversity of high quality outdoor recreational opportunities within parks for the pleasure and enjoyment of the citizens

of Manitoba and their guests in amounts and locations which respond firstly to provincial interests for rare, scarce or special forms of recreation and secondly, to regional demand and priorities"; and "to identify and designate as part of the system of Provincial Park Lands, areas of high recreational potential required to satisfy regional shortfalls in present or projected future public demand for outdoor recreation"; and finally, "to develop facilities and to encourage recreational use patterns with Parks which maximize the long-term recreational potential of these areas." (Manitoba Department of Natural Resources 1983c).

Additional guidelines for fisheries management are also included within the recently adopted Whiteshell Master Plan (Manitoba Department of Natural Resources 1983a):

- "Management for the maintenance and/or enhancement of opportunities for sport fishing will be emphasized in the Intensive Recreation Zones and will in general, involve habitat improvement and protection and stocking programs."
- "The stocking of walleye and other warm-water sport species will be considered, and to improve the success of stocking the possibility of developing rearing ponds for walleye will be investigated."
- "Regulations pertaining to sport fishing are reviewed annually and may be adjusted occasionally to ensure maintenance and enhancement of fishing opportunities."

Appendix D

SUMMARY OF ESTIMATES FROM ANGLER SURVEYS

Table D.1. Summary of Estimates for All Anglers for Falcon Lake. Confidence Intervals are $X \pm \underline{t}_{0.05}N(SE)$

Parameter	Estimate
# Parties	1935 ± 463
# Angler-days	4138 ± 1055
# Angler-hours	8250 ± 1820
# Fish kept	1644 ± 615
# Fish caught	2240 ± 785
# Pike kept	385 ± 222
# Pike caught	631 ± 348
# Walleye kept	1060 ± 525
# Walleye caught	1180 ± 568
# Smallmouth bass kept	127 ± 86
# Smallmouth bass caught	268 ± 287
# Perch kept	41 ± 68
# Perch caught	103 ± 153
# Anglers/party	2.1
# Hours angled/angler-day	2.0
# Fish kept/angler-day	0.40
# Fish caught/angler-day	0.54
# Pike kept/angler-day	0.09
# Pike caught/angler-day	0.15
# Walleye kept/angler-day	0.26
# Walleye caught/angler-day	0.29
# Fish kept/angler-hour	0.20
# Fish caught/angler-hour	0.27
# Pike kept/angler-hour	0.05
# Pike caught/angler-hour	0.08
# Walleye kept/angler-hour	0.13
# Walleye caught/angler-hour	0.14

Table D.2. Summary of Estimates by License Type for Falcon Lake. Confidence Intervals are X ± $t_{0.05}$N(SE)

Parameter	Non-resident (Season)	Non-resident (3 Day)	All Non-resident	Resident	Other	Resident + Other
# Parties	31 ± 36	4 ± 8	35 ± 36	1893 ± 460	8 ± 16	1900 ± 457
# Angler-days	77 ± 91	12 ± 18	89 ± 91	4004 ± 1052	45 ± 33	4049 ± 1048
# Angler-hours	485 ± 812	35 ± 47	520 ± 813	7549 ± 1787	182 ± 147	7730 ± 1782
# Fish kept	54 ± 97	0	54 ± 97	1581 ± 621	8 ± 5	1590 ± 621
# Fish caught	162 ± 324	8 ± 17	170 ± 324	2062 ± 764	8 ± 5	2070 ± 764
# Pike kept	0	0	0	379 ± 222	7 ± 9	385 ± 222
# Pike caught	108 ± 227	8 ± 17	116 ± 228	509 ± 231	7 ± 9	515 ± 232
# Walleye kept	8 ± 16	0	8 ± 16	1053 ± 529	0	1053 ± 529
# Walleye caught	8 ± 16	0	8 ± 16	1172 ± 572	0	1172 ± 572
# Smallmouth bass kept	46 ± 81	0	46 ± 81	80 ± 45	2 ± 5	81 ± 46
# Smallmouth bass caught	46 ± 81	0	46 ± 81	220 ± 284	2 ± 5	221 ± 284
# Perch kept	0	0	0	41 ± 68	0	41 ± 68
# Perch caught	0	0	0	103 ± 153	0	103 ± 153
# Anglers/party	-	-	-	2.1	-	2.1
# Hours angled/angler-day	-	-	-	1.9	4.0	1.9
# Fish kept/angler-day	-	-	-	0.39	0.18	0.39
# Fish caught/angler-day	-	-	-	0.51	0.18	0.51
# Pike kept/angler-day	-	-	-	0.09	-	0.10
# Pike caught/angler-day	-	-	-	0.13	-	0.13
# Walleye kept/angler-day	-	-	-	0.26	0	0.26
# Walleye caught/angler-day	-	-	-	0.29	0	0.29
# Fish kept/angler-hour	-	-	-	0.21	0.04	0.21
# Fish caught/angler-hour	-	-	-	0.27	0.04	0.27
# Pike kept/angler-hour	-	-	-	0.05	-	0.05
# Pike caught/angler-hour	-	-	-	0.07	-	0.07
# Walleye kept/angler-hour	-	-	-	0.14	0	0.14
# Walleye caught/angler-hour	-	-	-	0.16	0	0.15

- indicates datum not available

Table D.3. Summary of Estimates by Accommodation Type for Falcon Lake. Confidence Intervals are $X \pm t_{0.05}N(SE)$

Parameter	Cottage	Lodge	Campground	Other
# Parties	1176 ± 328	61 ± 42	529 ± 170	170 ± 61
# Angler-days	2312 ± 705	135 ± 86	1308 ± 462	383 ± 129
# Angler-hours	4293 ± 1191	451 ± 359	2277 ± 833	1229 ± 659
# Fish kept	1161 ± 507	46 ± 56	281 ± 225	155 ± 123
# Fish caught	1573 ± 659	62 ± 70	402 ± 248	204 ± 137
# Pike kept	172 ± 89	11 ± 14	128 ± 146	74 ± 70
# Pike caught	311 ± 303	26 ± 24	211 ± 170	83 ± 71
# Walleye kept	874 ± 457	12 ± 25	133 ± 84	42 ± 37
# Walleye caught	972 ± 499	12 ± 25	141 ± 84	54 ± 51
# Smallmouth bass kept	73 ± 47	23 ± 49	15 ± 22	15 ± 32
# Smallmouth bass caught	181 ± 217	23 ± 49	24 ± 25	40 ± 56
# Perch kept	33 ± 68	0	0	8 ± 16
# Perch caught	91 ± 152	0	4 ± 8	8 ± 16
# Anglers/party	2.0	2.2	2.5	2.3
# Hours angled/angler-day	1.9	3.3	1.7	3.2
# Fish kept/angler-day	0.50	-	0.21	0.40
# Fish caught/angler-day	0.68	-	0.31	0.53
# Pike kept/angler-day	0.07	-	-	0.19
# Pike caught/angler-day	0.13	0.19	0.16	0.22
# Walleye kept/angler-day	0.38	-	0.10	0.11
# Walleye caught/angler-day	0.42	-	0.11	0.14
# Fish kept/angler-hour	0.27	-	0.12	0.13
# Fish caught/angler-hour	0.37	-	0.18	0.17
# Pike kept/angler-hour	0.04	-	-	0.06
# Pike caught/angler-hour	0.07	0.06	0.09	0.07
# Walleye kept/angler-hour	0.20	-	0.06	0.03
# Walleye caught/angler-hour	0.23	-	0.06	0.04

- indicates datum not available

Table D.4. Summary of Estimates for Time Periods May 10 - June 30, and July 1 - September 1 1982 for Falcon Lake. Confidence Intervals are $X \pm t_{0.05}N(SE)$

Parameter	May 10-Jun 30[1]	July 1-Sep 1
# Parties	912 46%	1068 ± 418 54%
# Angler-days	1903 45%	2313 ± 1027 55%
# Angler-hours	4512 53%	4068 ± 1435 47%
# Fish kept	643 40%	980 ± 633 60%
# Fish caught	821 38%	1340 ± 690 62%
# Pike kept	254 -	164 ± 234 -
# Pike caught	424 -	241 ± 250 -
# Walleye kept	276 27%	728 ± 478 73%
# Walleye caught	284 26%	826 ± 491 74%
# Smallmouth bass kept	83 60%	55 ± 50 40%
# Smallmouth bass caught	83 -	167 ± 226 -
# Anglers/party	2.1	2.2
# Hours angled/angler-day	2.4	1.8
# Fish kept/angler-day	0.34	0.42
# Fish caught/angler-day	0.43	0.58
# Pike kept/angler-day	0.13	-
# Pike caught/angler-day	0.22	-
# Walleye kept/angler-day	0.15	0.31
# Walleye caught/angler-day	0.15	0.36
# Fish kept/angler-hour	0.14	0.24
# Fish caught/angler-hour	0.18	0.33
# Pike kept/angler-hour	0.06	-
# Pike caught/angler-hour	0.09	-
# Walleye kept/angler-hour	0.06	0.18
# Walleye caught/angler-hour	0.06	0.20

- indicates datum not available

[1] confidence intervals were not calculated due to too few data.

Table D.5. Summary of Estimates for All Anglers for Big Whiteshell Lake. Confidence Intervals are $X \pm t_{0.05}N(SE)$

Parameter	Estimate
# Parties	2536 ± 483
# Angler-days	6105 ± 1094
# Angler-hours	14779 ± 2866
# Fish kept	4618 ± 1311
# Fish caught	6069 ± 1740
# Pike kept	1899 ± 515
# Pike caught	2923 ± 897
# Walleye kept	2515 ± 837
# Walleye caught	2726 ± 914
# Perch kept	204 ± 56
# Perch caught	417 ± 154
# Anglers/party	2.4
# Hours angled/angler-day	2.4
# Fish kept/angler-day	0.76
# Fish caught/angler-day	0.99
# Pike kept/angler-day	0.31
# Pike caught/angler-day	0.48
# Walleye kept/angler-day	0.41
# Walleye caught/angler-day	0.45
# Fish kept/angler-hour	0.31
# Fish caught/angler-hour	0.41
# Pike kept/angler-hour	0.13
# Pike caught/angler-hour	0.20
# Walleye kept/angler-hour	0.17
# Walleye caught/angler-hour	0.18

Table D.6. Summary of Estimates by License Type for Big Whiteshell Lake. Confidence Intervals are $X \pm t_{0.05}N(SE)$

Statistics	Non-resident (Season)	Non-resident (3 Day)	All Non-resident	Resident	Other	Resident + Other
# Parties	141 ± 85	10 ± 11	151 ± 85	2379 ± 490	6 ± 9	2385 ± 492
# Angler-days	436 ± 273	22 ± 29	458 ± 273	5585 ± 1110	62 ± 55	5647 ± 1129
# Angler-hours	1495 ± 784	88 ± 130	1583 ± 787	13081 ± 2664	116 ± 81	13196 ± 2691
# Fish kept	462 ± 294	14 ± 18	476 ± 293	4124 ± 1184	17 ± 24	4141 ± 1186
# Fish caught	731 ± 486	22 ± 34	754 ± 485	5279 ± 1492	36 ± 26	5315 ± 1496
# Pike kept	132 ± 86	6 ± 9	138 ± 86	1749 ± 457	12 ± 20	1761 ± 457
# Pike caught	323 ± 241	6 ± 9	328 ± 240	2564 ± 734	31 ± 24	2595 ± 732
# Walleye kept	330 ± 248	0	330 ± 248	2180 ± 780	5 ± 8	2185 ± 780
# Walleye caught	409 ± 284	0	409 ± 284	2312 ± 819	5 ± 8	2317 ± 820
# Perch kept	0	8 ± 17	8 ± 17	196 ± 58	0	196 ± 58
# Perch caught	0	17 ± 34	17 ± 34	401 ± 149	0	401 ± 149
# Anglers/party	3.1	-	3.0	2.3	-	2.4
# Hours angled/angler-day	3.4	-	3.5	2.3	1.9	2.3
# Fish kept/angler-day	1.06	-	1.04	0.74	-	0.73
# Fish caught/angler-day	1.68	-	1.65	0.95	0.58	0.94
# Pike kept/angler-day	0.30	-	0.30	0.31	-	0.31
# Pike caught/angler-day	0.74	-	0.72	0.46	0.50	0.46
# Walleye kept/angler-day	0.76	-	0.72	0.39	-	0.39
# Walleye caught/angler-day	0.94	-	0.89	0.41	-	0.41
# Fish kept/angler-hour	0.31	-	0.30	0.32	-	0.31
# Fish caught/angler-hour	0.49	-	0.48	0.40	0.31	0.40
# Pike kept/angler-hour	0.09	-	0.09	0.13	-	0.13
# Pike caught/angler-hour	0.22	-	0.21	0.20	0.27	0.20
# Walleye kept/angler-hour	0.22	-	0.21	0.17	-	0.17
# Walleye caught/angler-hour	0.27	-	0.26	0.18	-	0.18

- indicates datum not available

Table D.7. Summary of Estimtes by Accommodation Type for Big Whiteshell Lake. Confidence Intervals are $X \pm t_{0.05}N(SE)$

Parameter	Cottage	Lodge	Campground	Other
# Parties	706 ± 147	342 ± 81	1233 ± 290	255 ± 96
# Angler-days	1606 ± 310	929 ± 199	2976 ± 704	593 ± 235
# Angler-hours	2776 ± 616	2560 ± 853	7143 ± 1433	2301 ± 1147
# Fish kept	812 ± 329	866 ± 460	2141 ± 618	798 ± 390
# Fish caught	1135 ± 512	1232 ± 631	2620 ± 684	1082 ± 587
# Pike kept	316 ± 123	459 ± 252	718 ± 240	405 ± 155
# Pike caught	536 ± 288	753 ± 387	1029 ± 300	605 ± 307
# Walleye kept	460 ± 227	424 ± 247	1259 ± 459	371 ± 298
# Walleye caught	506 ± 251	496 ± 279	1336 ± 474	388 ± 301
# Perch kept	36 ± 24	6 ± 9	141 ± 51	22 ± 18
# Perch caught	93 ± 56	6 ± 9	229 ± 80	89 ± 97
# Anglers/party	2.3	2.7	2.4	2.3
# Hours angled/angler-day	1.7	2.8	2.4	3.9
# Fish kept/angler-day	0.51	0.93	0.72	1.35
# Fish caught/angler-day	0.71	1.33	0.88	1.82
# Pike kept/angler-day	0.20	0.49	0.24	0.68
# Pike caught/angler-day	0.33	0.81	0.35	1.02
# Walleye kept/angler-day	0.29	0.46	0.42	0.63
# Walley caught/angler-day	0.32	0.53	0.45	0.65
# Fish kept/angler-day	0.29	0.34	0.30	0.35
# Fish caught/angler-hour	0.41	0.48	0.37	0.47
# Pike kept/angler-hour	0.11	0.18	0.10	0.18
# Pike caught/angler-hour	0.19	0.29	0.14	0.26
# Walleye kept/angler-hour	0.17	0.17	0.18	0.16
# Walleye caught/angler-hour	0.18	0.19	0.19	0.17

Table D.8. Summary of Estimates for Time Periods May 10 - June 30, and July 1 - September 1 1982 for Big Whiteshell Lake. Confidence Intervals are $X \pm t_{0.05}N(SE)$

Parameter	May 10-Jun 30		July 1-Sep 1	
# Parties	1308 ± 444	51%	1260 ± 373	49%
# Angler-days	3128 ± 738	51%	3046 ± 905	49%
# Angler-hours	8337 ± 2673	56%	6628 ± 1900	44%
# Fish kept	3525 ± 1079	74%	1213 ± 530	26%
# Fish caught	4599 ± 1380	74%	1623 ± 635	26%
# Pike kept	1570 ± 481	81%	367 ± 250	19%
# Pike caught	2439 ± 771	82%	549 ± 287	18%
# Walleye kept	1840 ± 622	71%	754 ± 399	29%
# Walleye caught	2015 ± 655	71%	804 ± 422	29%
# Perch kept	114 ± 59	56%	91 ± 46	44%
# Perch caught	144 ± 287	-	270 ± 147	-
# Anglers/party	2.4		2.4	
# Hours angled/angler-day	2.7		2.2	
# Fish kept/angler-day	1.13		0.40	
# Fish caught/angler-day	1.47		0.53	
# Pike kept/angler-day	0.50		0.12	
# Pike caught/angler-day	0.78		0.18	
# Walleye kept/angler-day	0.59		0.25	
# Walleye caught/angler-day	0.64		0.26	
# Fish kept/angler-hour	0.42		0.18	
# Fish caught/angler-hour	0.55		0.24	
# Pike kept/angler-hour	0.19		0.06	
# Pike caught/angler-hour	0.29		0.08	
# Walleye kept/angler-hour	0.22		0.11	
# Walleye caught/angler-hour	0.24		0.12	

- indicated datum not available

Table D.9. Summary of Estimates for All Anglers for Brereton Lake. Confidence Intervals are $X \pm \underline{t}_{0.05}N(SE)$

Parameter	Estimate
# Parties	2083 ± 425
# Angler-days	4593 ± 1096
# Angler-hours	11590 ± 3225
# Fish kept	3885 ± 1470
# Fish caught	4841 ± 1774
# Pike kept	487 ± 179
# Pike caught	723 ± 248
# Walleye kept	3002 ± 1426
# Walleye caught	3287 ± 1661
# Perch kept	396 ± 178
# Perch caught	831 ± 365
# Anglers/party	2.2
# Hours angled/angler-day	2.5
# Fish kept/angler-day	0.85
# Fish caught/angler-day	1.05
# Pike kept/angler-day	0.11
# Pike caught/angler-day	0.16
# Walleye kept/angler-day	0.65
# Walley caught/angler-day	0.72
# Fish kept/angler-day	0.34
# Fish caught/angler-hour	0.42
# Pike kept/angler-hour	0.04
# Pike caught/angler-hour	0.06
# Walleye kept/angler-hour	0.26
# Walleye caught/angler-hour	0.28

Table D.10. Summary of Estimates by License Type for Brereton Lake. Confidence Intervals are X ± $t_{0.05}$N(SE)

Statistics	Non-resident (Season)	Non-resident (3 Day)	All Non-resident	Resident	Other	Resident + Other
# Parties	30 ± 24	14 ± 19	44 ± 27	2027 ± 421	12 ± 16	2038 ± 418
# Angler-days	89 ± 65	35 ± 50	124 ± 68	4341 ± 1095	128 ± 150	4469 ± 1083
# Angler-hours	493 ± 405	7 ± 14	500 ± 402	10788 ± 3143	301 ± 299	11090 ± 3185
# Fish kept	122 ± 180	0	122 ± 180	3740 ± 1420	23 ± 51	3764 ± 1420
# Fish caught	136 ± 179	7 ± 14	143 ± 175	4675 ± 1725	23 ± 51	4698 ± 1724
# Pike kept	0	0	0	479 ± 180	8 ± 23	487 ± 179
# Pike caught	14 ± 29	7 ± 14	21 ± 31	694 ± 251	8 ± 23	702 ± 250
# Walleye kept	122 ± 180	0	122 ± 180	2872 ± 1377	8 ± 12	2881 ± 1377
# Walleye caught	122 ± 180	0	122 ± 180	3157 ± 1625	8 ± 12	3165 ± 1625
# Perch kept	0	0	0	389 ± 178	7 ± 54	396 ± 178
# Perch caught	0	0	0	824 ± 365	7 ± 54	831 ± 365
# Anglers/party	3.0	-	2.8	2.1	-	2.2
# Hours angled/angler-day	5.5	-	4.0	2.5	-	2.5
# Fish kept/angler-day	-	-	-	0.86	-	0.84
# Fish caught/angler-day	-	-	-	1.08	-	1.05
# Pike kept/angler-day	0	-	0	0.11	-	0.11
# Pike caught/angler-day	-	-	-	0.16	-	0.16
# Walleye kept/angler-day	-	-	-	0.66	-	0.64
# Walley caught/angler-day	-	-	-	0.73	-	0.71
# Fish kept/angler-day	-	-	-	0.35	-	0.34
# Fish caught/angler-hour	-	-	-	0.43	-	0.42
# Pike kept/angler-hour	0	-	0	0.04	-	0.04
# Pike caught/angler-hour	-	-	-	0.06	-	0.06
# Walleye kept/angler-hour	-	-	-	0.27	-	0.26
# Walleye caught/angler-hour	-	-	-	0.29	-	0.29

- indicates datum not available

Table D.11. Summary of Estimates by Accommodation Type for Brereton Lake. Confidence Intervals are $X \pm t_{0.05}N(SE)$

Parameter	Cottage	Lodge	Transient Campground	Seasonal Campground	All Campground	Other
# Parties	992 ± 267	138 ± 86	307 ± 107	161 ± 60	467 ± 155	486 ± 173
# Angler-days	2090 ± 631	362 ± 245	716 ± 253	383 ± 149	1098 ± 359	1042 ± 429
# Angler-hours	3525 ± 1166	1097 ± 1221	2131 ± 982	782 ± 451	2913 ± 1222	4055 ± 1591
# Fish kept	1372 ± 646	323 ± 342	484 ± 266	124 ± 62	608 ± 269	1583 ± 752
# Fish caught	1742 ± 786	461 ± 380	603 ± 312	149 ± 81	752 ± 332	1887 ± 1034
# Pike kept	207 ± 82	65 ± 94	44 ± 35	52 ± 48	96 ± 59	119 ± 88
# Pike caught	260 ± 129	109 ± 103	88 ± 47	61 ± 50	149 ± 73	206 ± 155
# Walleye kept	970 ± 611	200 ± 191	365 ± 223	65 ± 38	431 ± 235	1402 ± 718
# Walleye caught	1057 ± 689	218 ± 204	392 ± 241	70 ± 40	462 ± 262	1549 ± 892
# Perch kept	196 ± 145	58 ± 67	75 ± 115	7 ± 14	82 ± 118	60 ± 62
# Perch caught	397 ± 348	162 ± 167	123 ± 126	18 ± 23	141 ± 135	132 ± 115
# Anglers/party	2.1	2.6	2.3	2.4	2.4	2.1
# Hours angled/angler-day	1.7	-	3.0	2.0	2.7	3.9
# Fish kept/angler-day	0.66	-	0.68	0.32	0.55	1.52
# Fish caught/angler-day	0.83	1.27	0.84	0.39	0.68	1.81
# Pike kept/angler-day	0.10	-	0.06	0.14	0.09	0.11
# Pike caught/angler-day	0.12	0.30	0.12	0.16	0.14	0.20
# Walleye kept/angler-day	0.46	0.55	0.51	0.17	0.39	1.35
# Walley caught/angler-day	0.51	0.60	0.55	0.18	0.42	1.49
# Fish kept/angler-day	0.39	-	0.23	0.16	0.21	0.39
# Fish caught/angler-hour	0.49	-	0.28	0.19	0.26	0.47
# Pike kept/angler-hour	0.06	-	0.02	0.07	0.03	0.03
# Pike caught/angler-hour	0.07	-	0.04	0.08	0.05	0.05
# Walleye kept/angler-hour	0.28	-	0.17	0.08	0.15	0.35
# Walleye caught/angler-hour	0.30	-	0.18	0.09	0.16	0.38

- indicates datum not available

Table D.12. Summary of Estimates for Time Periods May 11 - June 30, and July 1 - September 2 1983 for Brereton Lake. Confidence Intervals are $X \pm t_{0.05}N(SE)$

Parameter	May 10-Jun 30		July 1-Sep 1	
# Parties	786 ± 324	40%	1166 ± 287	60%
# Angler-days	1838 ± 658	43%	2411 ± 604	57%
# Angler-hours	5024 ± 1835	47%	5696 ± 1958	53%
# Fish kept	1947 ± 1923	54%	1629 ± 683	46%
# Fish caught	2233 ± 1392	50%	2202 ± 974	50%
# Pike kept	285 ± 129	58%	205 ± 165	42%
# Pike caught	354 ± 161	50%	353 ± 272	50%
# Walleye kept	1536 ± 1308	56%	1198 ± 655	44%
# Walleye caught	1612 ± 1464	55%	1345 ± 854	45%
# Perch kept	127 ± 113	36%	226 ± 131	64%
# Perch caught	267 ± 205	35%	505 ± 300	65%
# Anglers/party	2.3		2.1	
# Hours angled/angler-day	2.7		2.4	
# Fish kept/angler-day	1.06		0.68	
# Fish caught/angler-day	1.21		0.91	
# Pike kept/angler-day	0.16		0.09	
# Pike caught/angler-day	0.19		0.15	
# Walleye kept/angler-day	0.84		0.50	
# Walleye caught/angler-day	0.88		0.56	
# Fish kept/angler-hour	0.39		0.29	
# Fish caught/angler-hour	0.44		0.39	
# Pike kept/angler-hour	0.06		0.04	
# Pike caught/angler-hour	0.07		0.06	
# Walleye kept/angler-hour	0.31		0.21	
# Walleye caught/angler-hour	0.32		0.24	

Table D.13. Summary of Estimates for All Anglers for Nutimik Lake. Confidence Intervals are $X \pm t_{0.05}N(SE)$

Parameter	Estimate
# Parties	2213 ± 514
# Angler-days	4985 ± 1070
# Angler-hours	13922 ± 4088
# Fish kept	3562 ± 921
# Fish caught	4877 ± 1294
# Pike kept	145 ± 83
# Pike caught	380 ± 172
# Walleye kept	1018 ± 312
# Walleye caught	1327 ± 381
# Perch kept	49 ± 23
# Perch caught	122 ± 87
# Smallmouth bass kept	119 ± 88
# Smallmouth bass cught	269 ± 243
# Mooneye kept	381 ± 307
# Mooneye caught	381 ± 307
# Sauger kept	1750 ± 650
# Sauger caught	2285 ± 813
# Lake sturgeon kept	92 ± 55
# Lake sturgeon caught	106 ± 62
# Anglers/party	2.3
# Hours angled/angler-day	2.8
# Fish kept/angler-day	0.71
# Fish caught/angler-day	0.98
# Pike kept/angler-day	0.03
# Pike caught/angler-day	0.08
# Walleye kept/angler-day	0.20
# Walley caught/angler-day	0.27
# Sauger kept/angler-day	0.35
# Sauger caught/angler-day	0.46
# Lake sturgeon kept/angler-day	0.02
# Lake sturgeon caught	0.02
# Fish kept/angler-day	0.26
# Fish caught/angler-hour	0.35
# Pike kept/angler-hour	0.01
# Pike caught/angler-hour	0.03
# Walleye kept/angler-hour	0.07
# Walleye caught/angler-hour	0.10
# Sauger kept/angler-hour	0.13
# Sauger caught/angler-hour	0.16
# Lake sturgeon kept/angler-hour	0.01
# Lake sturgeon caught/angler-hour	0.01

Table D.14. Summary of Estimates by License Type for Nutimik Lake. Confidence Intervals are $X \pm t_{0.05}N(SE)$

Parameter	Non-resident (Season)	Non-resident (3 Day)	All Non-resident	Resident	Other	Resident + Other
# Parties	41 ± 34	21 ± 22	62 ± 49	2149 ± 500	2 ± 13	2150 ± 500
# Angler-days	118 ± 115	42 ± 50	160 ± 151	4812 ± 1028	13 ± 18	4825 ± 1033
# Angler-hours	286 ± 324	56 ± 68	342 ± 354	13513 ± 4041	66 ± 95	13580 ± 4060
# Fish kept	77 ± 79	21 ± 43	98 ± 99	3464 ± 898	0	3464 ± 898
# Fish caught	101 ± 98	21 ± 43	122 ± 113	4755 ± 1244	0	4755 ± 1244
# Pike kept	7 ± 14	7 ± 14	14 ± 19	131 ± 82	0	131 ± 82
# Pike caught	21 ± 43	7 ± 14	28 ± 44	352 ± 160	0	352 ± 160
# Walleye kept	7 ± 14	14 ± 29	21 ± 31	997 ± 305	0	997 ± 305
# Walleye caught	7 ± 14	14 ± 29	21 ± 31	1306 ± 372	0	1306 ± 372
# Perch kept	0	0	0	49 ± 23	0	49 ± 23
# Perch caught	0	0	0	122 ± 87	0	122 ± 87
# Smallmouth bass kept	40 ± 50	0	40 ± 50	80 ± 65	0	80 ± 65
# Smallmouth bass caught	49 ± 55	0	49 ± 55	220 ± 209	0	220 ± 209
# Mooneye kept	24 ± 51	0	24 ± 51	358 ± 306	0	358 ± 306
# Mooneye caught	24 ± 51	0	24 ± 51	358 ± 306	0	358 ± 306
# Sauger kept	0	0	0	1750 ± 650	0	1750 ± 650
# Sauger caught	0	0	0	2285 ± 813	0	2285 ± 813
# Lake sturgeon kept	0	0	0	92 ± 55	0	92 ± 55
# Lake sturgeon caught	0	0	0	106 ± 62	0	106 ± 62

Table D.14. Continued

Parameter	Non-resident (Season)	Non-resident (3 Day)	All Non-resident	Resident	Other	Resident + Other
# Angler/party	2.9	-	2.6	2.2	-	2.2
# Hours Angled/angler-day	-	-	-	2.8	-	2.8
# Fish kept/angler-day	-	-	-	0.72	-	0.72
# Fish caught/angler-day	0.86	-	0.76	0.99	-	0.99
# Pike kept/angler-day	-	-	-	0.03	-	0.03
# Pike caught/angler-day	-	-	-	0.07	-	0.07
# Walleye kept/angler-day	-	-	-	0.21	-	0.21
# Walleye caught/angler-day	-	-	-	0.27	-	0.27
# Sauger kept/angler-day	0	-	0	0.36	-	0.36
# Sauger caught/angler-day	0	-	0	0.47	-	0.47
# Lake sturgeon kept/angler-day	0	-	0	0.02	-	0.02
# Lake sturgeon caught/angler-day	0	-	0	0.02	-	0.02
# Fish kept/angler-hour	-	-	-	0.26	-	0.26
# Fish caught/angler-hour	-	-	-	0.35	-	0.35
# Pike kept/angler-hour	-	-	-	0.01	-	0.01
# Pike caught/angler-hour	-	-	-	0.03	-	0.03
# Walleye kept/angler-hour	-	-	-	0.07	-	0.07
# Walleye caught/angler-hour	-	-	-	0.10	-	0.10
# Sauger kept/angler-hour	-	-	-	0.13	-	0.13
# Sauger caught/angler-hour	-	-	-	0.17	-	0.17
# Lake sturgeon kept/angler-hour	-	-	-	0.01	-	0.01
# Lake sturgeon caught/angler-hour	-	-	-	0.01	-	0.01

- indicates datum not available

Table D.15. Summary of Estimates by Accommodation Type for Nutimik Lake. Confidence Intervals are $X \pm \underline{t}_{0.05}N(SE)$

Parameter	Cottage	Lodge	Transient Campground	Seasonal Campground	All Campground	Other
# Parties	946 ± 270	69 ± 52	540 ± 183	368 ± 125	908 ± 262	290 ± 113
# Angler-days	1983 ± 494	188 ± 141	1267 ± 434	834 ± 289	2101 ± 628	713 ± 305
# Angler-hours	5227 ± 1819	418 ± 319	3337 ± 1233	2240 ± 1170	5576 ± 2105	2700 ± 1245
# Fish kept	1849 ± 546	189 ± 51	564 ± 271	602 ± 331	1166 ± 487	359 ± 213
# Fish caught	2342 ± 653	227 ± 176	920 ± 430	847 ± 414	1766 ± 642	541 ± 281
# Pike kept	28 ± 32	14 ± 19	61 ± 74	8 ± 11	69 ± 74	35 ± 39
# Pike caught	88 ± 50	28 ± 44	159 ± 147	30 ± 33	189 ± 151	74 ± 65
# Walleye kept	565 ± 223	14 ± 19	184 ± 100	180 ± 148	364 ± 210	75 ± 48
# Walleye caught	661 ± 221	14 ± 19	256 ± 141	271 ± 200	527 ± 237	124 ± 85
# Perch kept	49 ± 23	0	0	0	0	0
# Perch caught	103 ± 83	0	19 ± 43	0	19 ± 43	0
# Smallmouth bass kept	58 ± 63	40 ± 50	9 ± 20	0	9 ± 20	12 ± 16
# Smallmouth bass caught	58 ± 63	49 ± 55	105 ± 174	5 ± 10	110 ± 176	52 ± 63
# Mooneye kept	252 ± 258	101 ± 113	28 ± 43	0	28 ± 43	0
# Mooneye caught	252 ± 258	101 ± 113	28 ± 43	0	28 ± 43	0
# Sauger kept	851 ± 369	21 ± 43	263 ± 164	398 ± 229	660 ± 336	218 ± 173
# Sauger caught	1125 ± 440	35 ± 72	333 ± 192	520 ± 299	853 ± 425	272 ± 217
# Lake sturgeon kept	45 ± 34	0	19 ± 30	16 ± 23	35 ± 35	12 ± 16
# Lake sturgeon caught	54 ± 45	0	19 ± 30	21 ± 32	40 ± 40	12 ± 16

Table D.15. Continued

Parameter	Cottage	Lodge	Transient Campground	Seasonal Campground	All Campground	Other
# Angler/party	2.1	2.7	2.3	2.3	2.3	2.5
# Hours Angled/angler-day	2.6	2.2	2.6	2.7	2.7	3.8
# Fish kept/angler-day	0.93	1.01	0.45	0.72	0.55	0.50
# Fish caught/angler-day	1.18	1.21	0.73	1.02	0.84	0.76
# Pike kept/angler-day	-	-	-	-	-	-
# Pike caught/angler-day	0.04	-	0.13	-	0.09	0.10
# Walleye kept/angler-day	0.28	-	0.15	0.22	0.17	0.11
# Walleye caught/angler-day	0.33	-	0.20	0.32	0.25	0.17
# Sauger kept/angler-day	0.43	-	0.21	0.48	0.31	0.31
# Sauger caught/angler-day	0.57	-	0.26	0.62	0.41	0.38
# Lake sturgeon kept/angler-day	0.02	0	-	-	0.02	-
# Lake sturgeon caught/angler-day	0.03	0	-	-	0.02	-
# Fish kept/angler-hour	0.35	0.45	0.17	0.27	0.21	0.13
# Fish caught/angler-hour	0.45	0.54	0.28	0.38	0.32	0.20
# Pike kept/angler-hour	-	-	-	-	-	-
# Pike caught/angler-hour	0.02	-	0.05	-	0.03	0.03
# Walleye kept/angler-hour	0.11	-	0.06	0.08	0.07	0.03
# Walleye caught/angler-hour	0.13	-	0.08	0.12	0.09	0.05
# Sauger kept/angler-hour	0.16	-	0.08	0.18	0.12	0.08
# Sauger caught/angler-hour	0.22	-	0.10	0.23	0.15	0.10
# Lake sturgeon kept/angler-hour	0.01	0	-	-	0.01	-
# Lake sturgeon caught/angler-hour	0.01	0	-	-	0.01	-

- indicates datum not available

Table D.16. Summary of Estimates for Time Periods May 11 - June 30, and July 1 - September 2 1983 for Nutimik Lake. Confidence Intervals are $X \pm t_{0.05}N(SE)$

Parameter	May 10-Jun 30[1]		July 1-Sep 1	
# Parties	832	36%	1497 ± 368	64%
# Angler-days	1934	37%	3317 ± 779	63%
# Angler-hours	5667	38%	9314 ± 2890	62%
# Fish kept	1230	32%	2570 ± 590	68%
# Fish caught	1701	33%	3443 ± 904	67%
# Pike kept	82	-	79 ± 84	-
# Pike caught	219	53%	196 ± 162	47%
# Walleye kept	461	43%	618 ± 174	57%
# Walleye caught	583	43%	788 ± 158	57%
# Perch kept	0	0%	42 ± 19	100%
# Perch caught	0	0%	110 ± 89	100%
# Mooneye kept	0	0%	388 ± 307	100%
# Mooneye caught	0	0%	388 ± 307	100%
# Sauger kept	637	33%	1266 ± 597	67%
# Sauger caught	810	33%	1637 ± 716	67%
# Lake sturgeon kept	0	0%	84 ± 48	100%
# Lake sturgeon caught	0	0%	95 ± 52	100%
# Anglers/party	2.3		2.2	
# Hours angled/angler-day	2.9		2.8	
# Fish kept/angler-day	0.64		0.77	
# Fish caught/angler-day	0.88		1.04	
# Pike kept/angler-day	0.04		-	
# Pike caught/angler-day	0.11		0.06	
# Walleye kept/angler-day	0.24		0.19	
# Walleye caught/angler-day	0.30		0.24	
# Sauger kept/angler-day	0.33		0.38	
# Sauger caught/angler-day	0.42		0.49	
# Lake sturgeon kept/angler-day	0		0.03	
# Lake sturgeon caught/angler-day	0		0.03	
# Fish kept/angler-hour	0.22		0.28	
# Fish caught/angler-hour	0.30		0.37	
# Pike kept/angler-hour	0.01		-	
# Pike caught/angler-hour	0.04		0.02	
# Walleye kept/angler-hour	0.08		0.07	
# Walleye caught/angler-hour	0.10		0.08	
# Sauger kept/angler-hour	0.11		0.14	
# Sauger caught/angler-hour	0.14		0.18	
# Lake sturgeon kept/angler-hour	0		0.01	
# Lake sturgeon caught/angler-hour	0		0.01	

- indicates datum not available

[1] confidence intervals were not calculated due to too few data

How accurate is creel census information?